A SEDIMENTOLOGICAL AND PALAEOECOLOGICAL STUDY OF OXFORDIAN (UPPER JURASSIC) CORAL-DOMINATED REEFAL CARBONATES IN WESTERN EUROPE

(Volume 2: Plates and Appendices)

by

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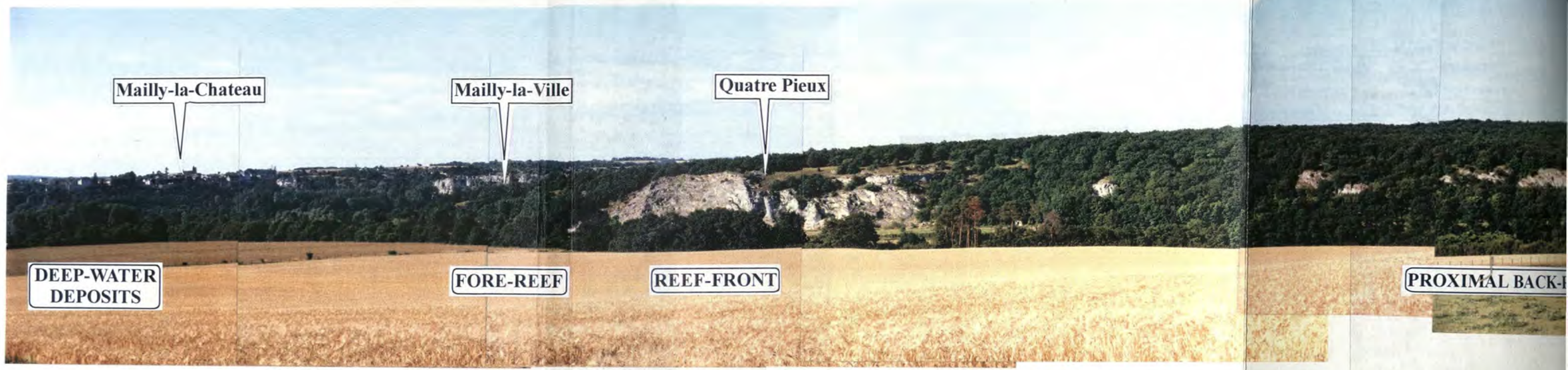
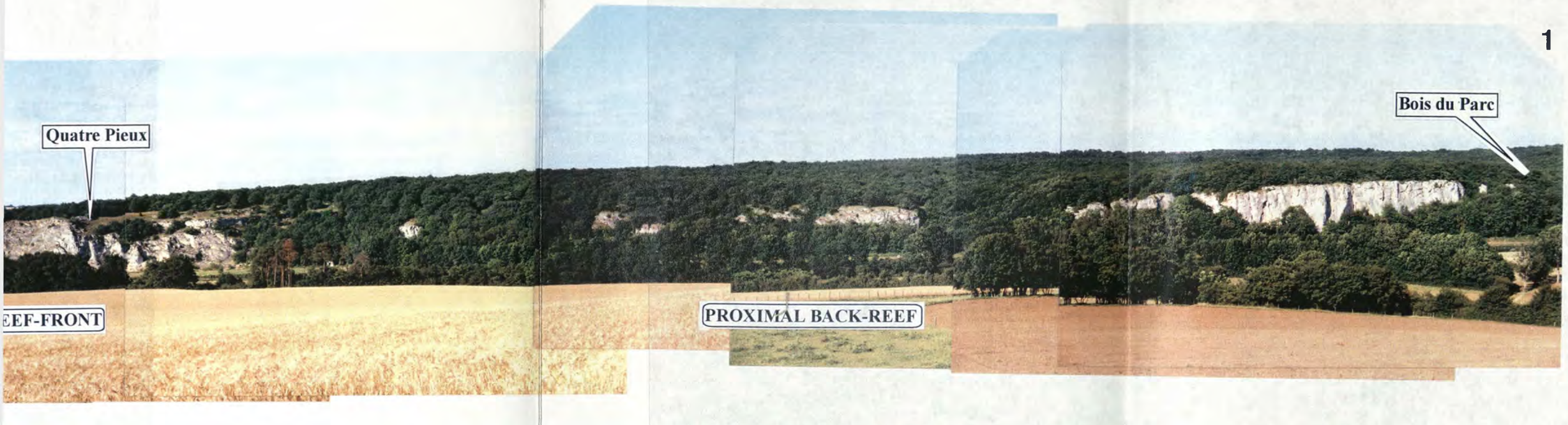
Figure 1: Photomontage of the northern margin of the Burgundy carbonate platform looking east across the Yonne from *La Ripe* farm. Field of view approximately 3.8 km.

Figure 2: Photomontage of the Châtel-Censoir section showing the shallowing upwards sequence from pre-reefal micritic mudstones through to transitional units, and then to the reef itself. This reefal unit corresponds to the Complexe récifal inférieur. The Complexe récifal supérieur (upper reefs) crops out right at the top of this section. Field of view approximately 250 m.


Mailly-la-Chateau
Mailly-la-Ville
Quatre Pieux
DEEP-WATER DEPOSITS
FORE-REEF
REEF-FRONT
PROXIMAL BACK-


Microselenid biostrome
Upper reefal units
Microselen biostrome

1


Quatre Pieux
EEF-FRONT
PROXIMAL BACK-REEF
Bois du Parc

2


Upper reefal units
Microselenid biostrome
Transitional limestones
Pre-reefal micritic limestones

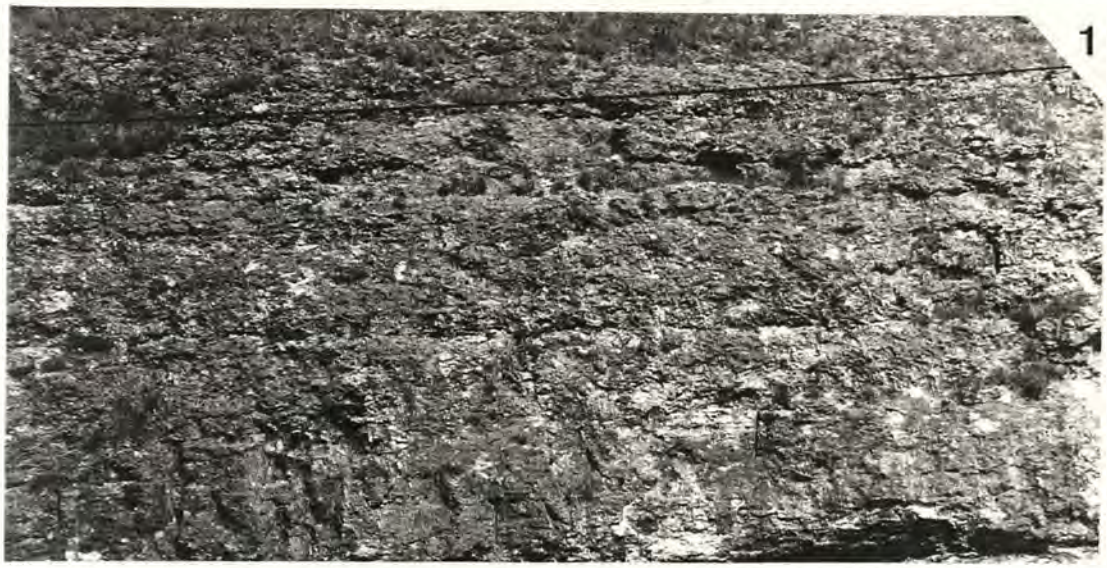
Plate 2.2: Details of the reefal fabrics and corals of the Châtel-Censoir reef; Complexe récifal inférieur

Figure 1: Details of the metre scale bedding of the biostrome.

Figure 2: Details of the reefal fabric of the biostrome. Framework construction is almost exclusively by platy corals. Coral skeletal biovolume approximately 30%. Hammer 32 cm.

Figure 3: Details of the platy coral growth form. Note partial mortality of the "parent" colony and subsequent regeneration developing "daughter" colonies. Pen 15 cm.

All three fabrics are dominated by microsolenid corals.



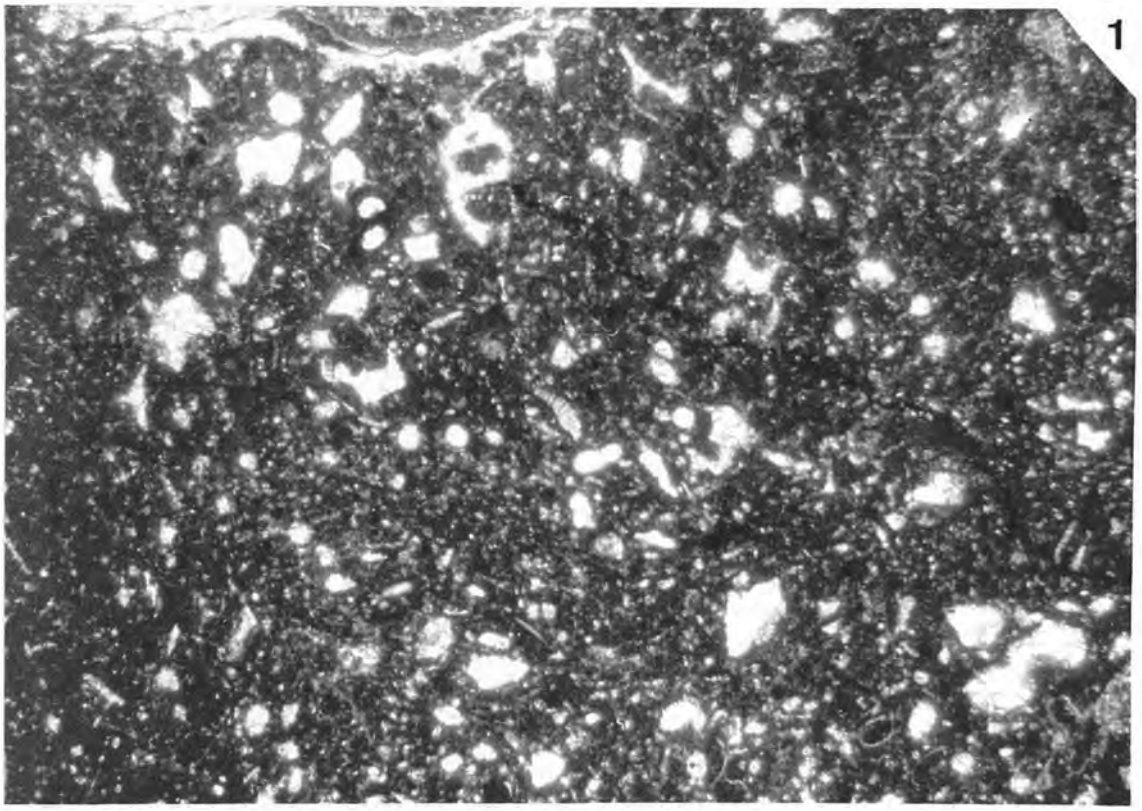
1

2

3

Plate 2.3: Intra-reef sediment microfacies of Châtel-Censoir reef; Complexe récifal inférieur

Figures 1-2: Bioclastic wackestones (biomicrites). Note that the bioclasts, which are fine grained, angular and poorly sorted, are not highly micritized and lack spongiostromate coatings. The most abundant bioclasts are of corals, echinoids and bivalves, although fragments of serpulids, forams and sponge spicules are also present. The matrix is completely micritic and mainly composed of very fine detrital material. Note the lack of peloidal laminations or rinds. Height of frames 4 mm.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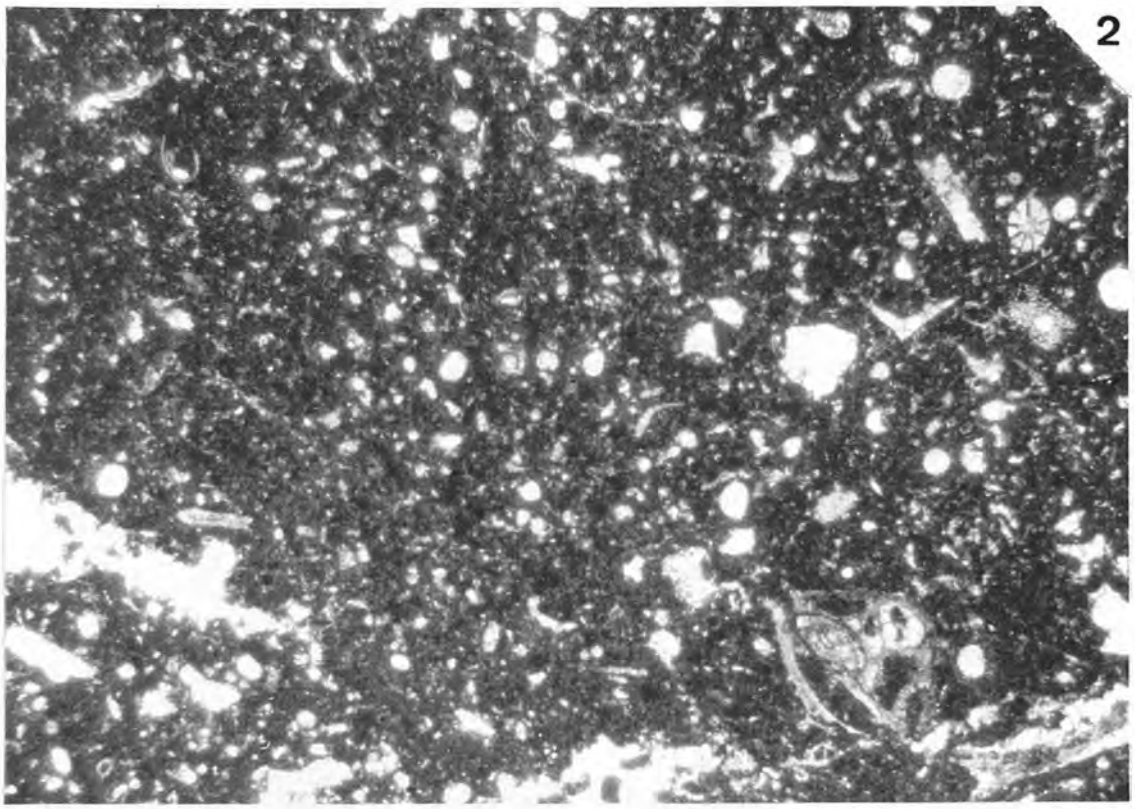
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Plate 2.4: Reef and associated facies; Quatre Pieux section; Complexe récifal supérieur

Figure 1: The Quatre Pieux section showing a sequence from reef framework at the base at the base of the section, to beach facies at the top. The steep rise of the reef facies to the right of the figure is a function of the foreground position of this part of the outcrop and does not represent primary reef topography. Jeep 1.45 m high.

Figure 2: Diceratid pelmicrites. These diceratid deposits often occur within lensoid channels a few metres across. Ruler 6.5 inches long.

Figure 3: Beach facies. Many of the rounded pebbles are polished coral fragments. Scale in inches.

1

2

3

Plate 2.5: Reef facies; Quatre Pieux section; Complexe récifal supérieur

Figure 1: General view of the reef fabric. The intra-reef sediment is a hard, dense, cream coloured microbial biopelmicrite. Note its brecciated appearance which is a consequence of the early cementation of the microbial-biopelmicrite. Pen 14 cm.

Figures 2-3: Details of the microbialite facies of figure 1. Figure 2: Microbial biopelmicrite with large pelmicrite intraclasts and macroscopic laminations; height of frame is 20 cm. Figure 3: Rapid variations from microbial biopelmicrite to intraclastic grainstone; height of frame is 15 cm.

1

2

3

Plate 2.6: Intra-reef sediment microfacies; Quatre Pieux section; Complexe récifal supérieur

Figures 1-2: General view of the laminated and rindy peloidal fabrics that dominate the intra-reef sediment of the Quatre Pieux reef. Also note the relatively low amounts of coarse grade bioclastic material and their immature character. Height of frames 3.4 cm; both figures are negative prints from thin sections. See plate 2.7-figs 1-2 for details of the laminated peloidal fabrics.


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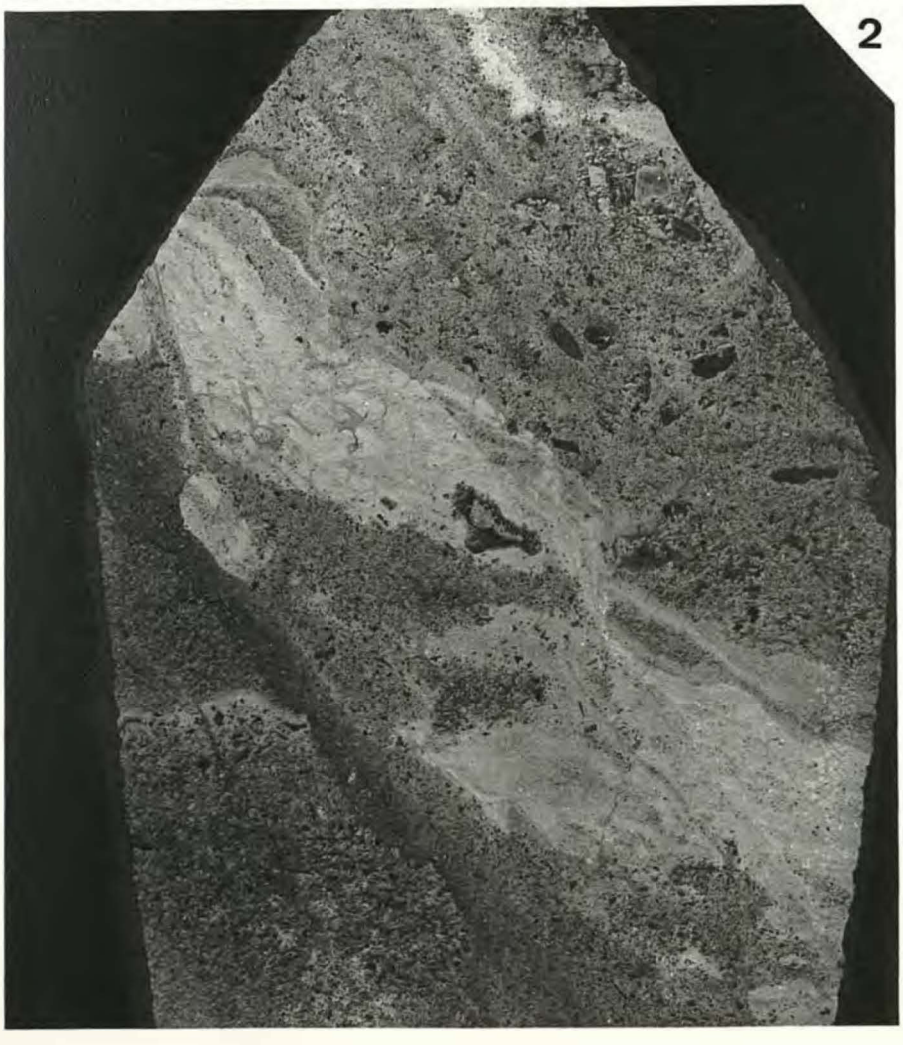
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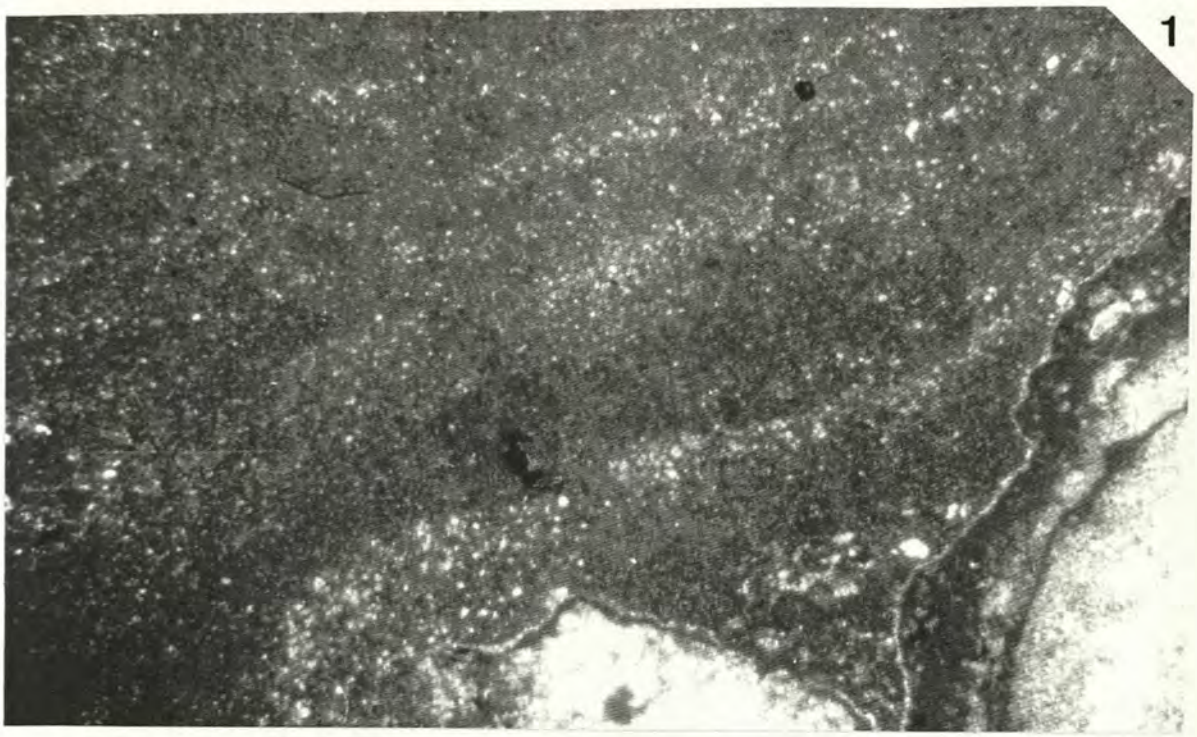
Plate 2.7: Intra-reef sediment microfacies; Quatre Pieux section; Complexe récifal supérieur

Figures 1-2: Details of the laminated peloidal fabrics shown in plate 2.6. These laminated fabrics conform to the agglutinated stromatolites of Riding (1991). Note dark spongiostromate crusts that have developed on the coral fragments. Figure 1: height of frame 3 mm; figure 2: height of frame 2.5 mm. See text for details.

Figure 3: Intraclastic grainstone composed of pelmicritic and biopelmicritic intraclasts set in a sparry cement. Height of frame 3 mm.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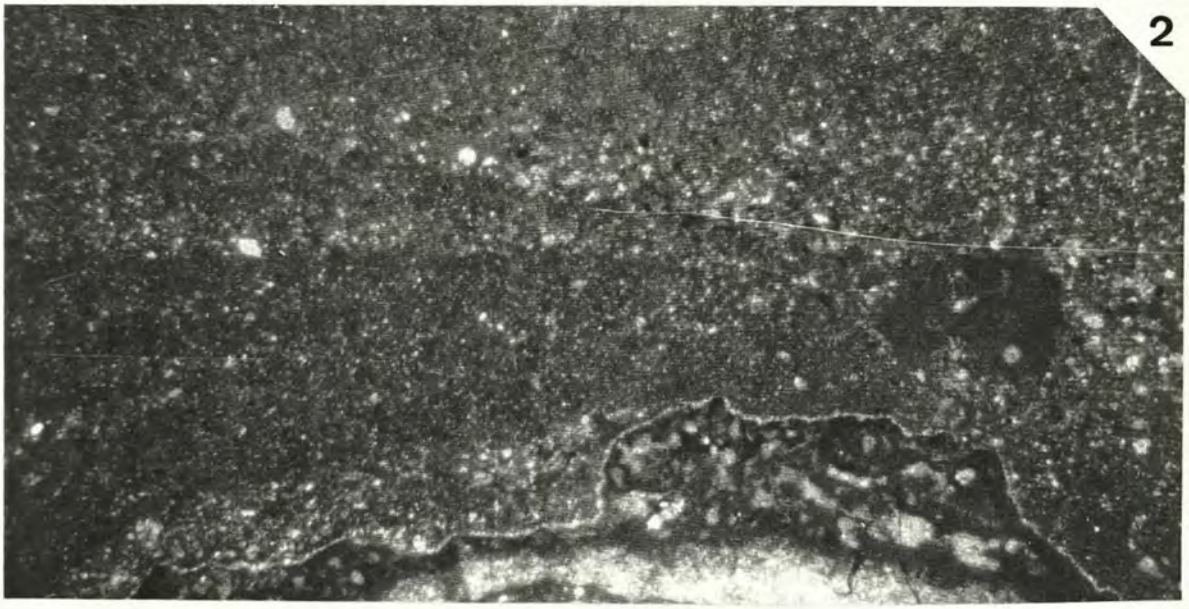
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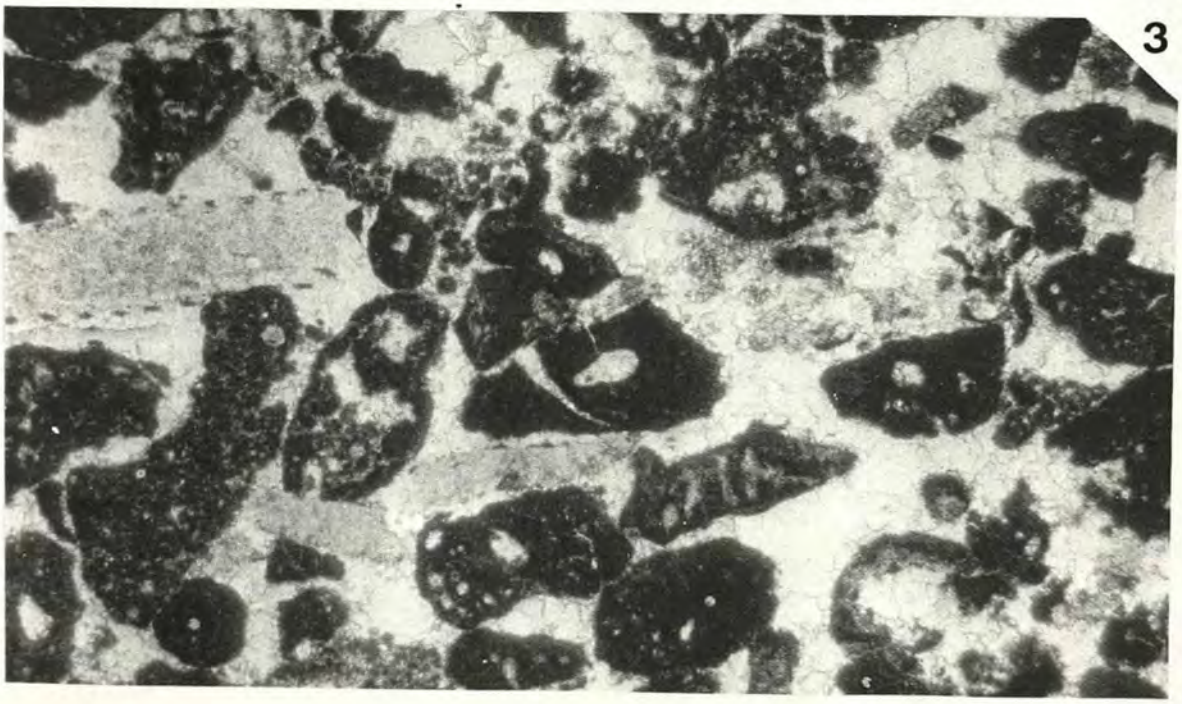
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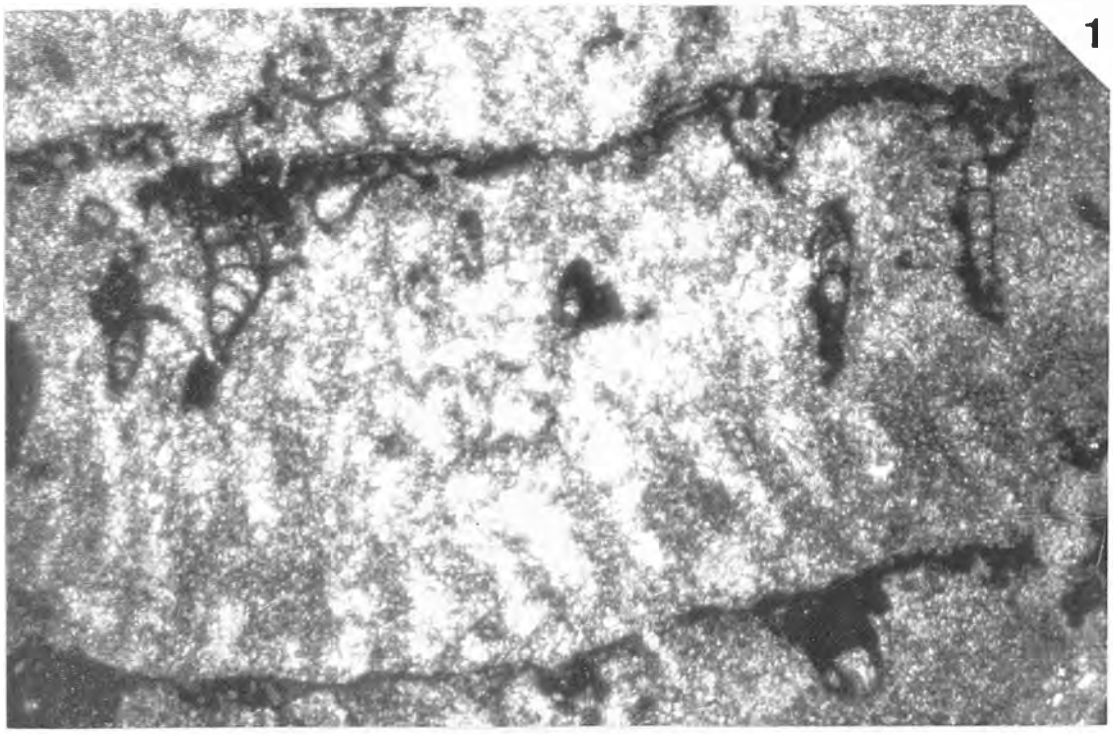
Plate 2.8: Coral and associated fauna; Quatre Pieux section; Complexe récifal supérieur

Figure 1: Boring forams (cf. *Bullopora*) drilling into an unidentified coral; height of frame 1.5 mm.

Figure 2: Details of two of the boring forams in figure 1; height of frame 0.5 mm.

Figure 3: *Berenicea*-type bryozoan which encrust the branching phaceloid corals. Height of frame 1 cm.

Figure 4: *Pseudocoenia*. Transverse section; negative print from thin section. Calices 8 mm across.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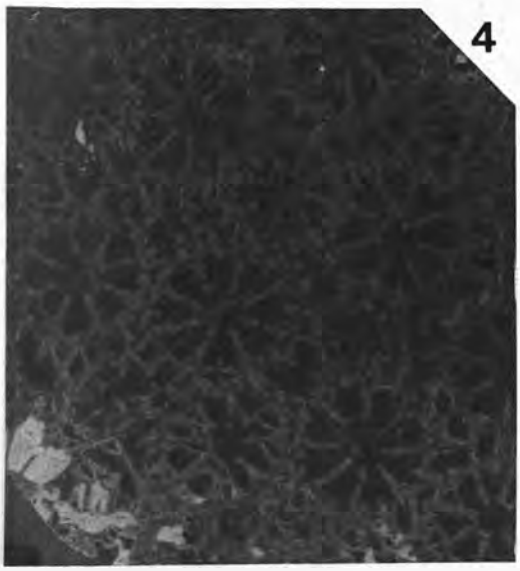
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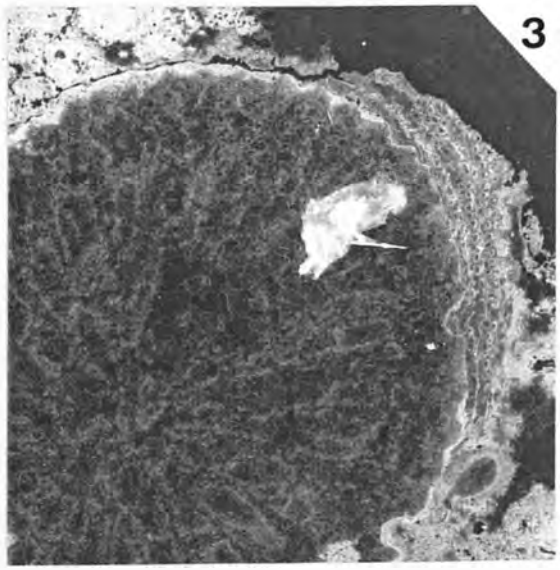
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Plate 2.9: Framebuilders; *Mitrodendron* and *Donacosmilia*; Quatre Pieux section; Complexe récifal supérieur

Figures 1-2 : Large colony of the phaceloid branching amphiastrid *Mitrodendron*; ruler 6.5 inches long. Figure 2: Calicular details of figure 1.

Figure 3: Epithecal banding on the phaceloid branching amphiastrid *Donacosmilia.* Growth band spacing approximately 0.5-0.8 mm. Scale in mm.

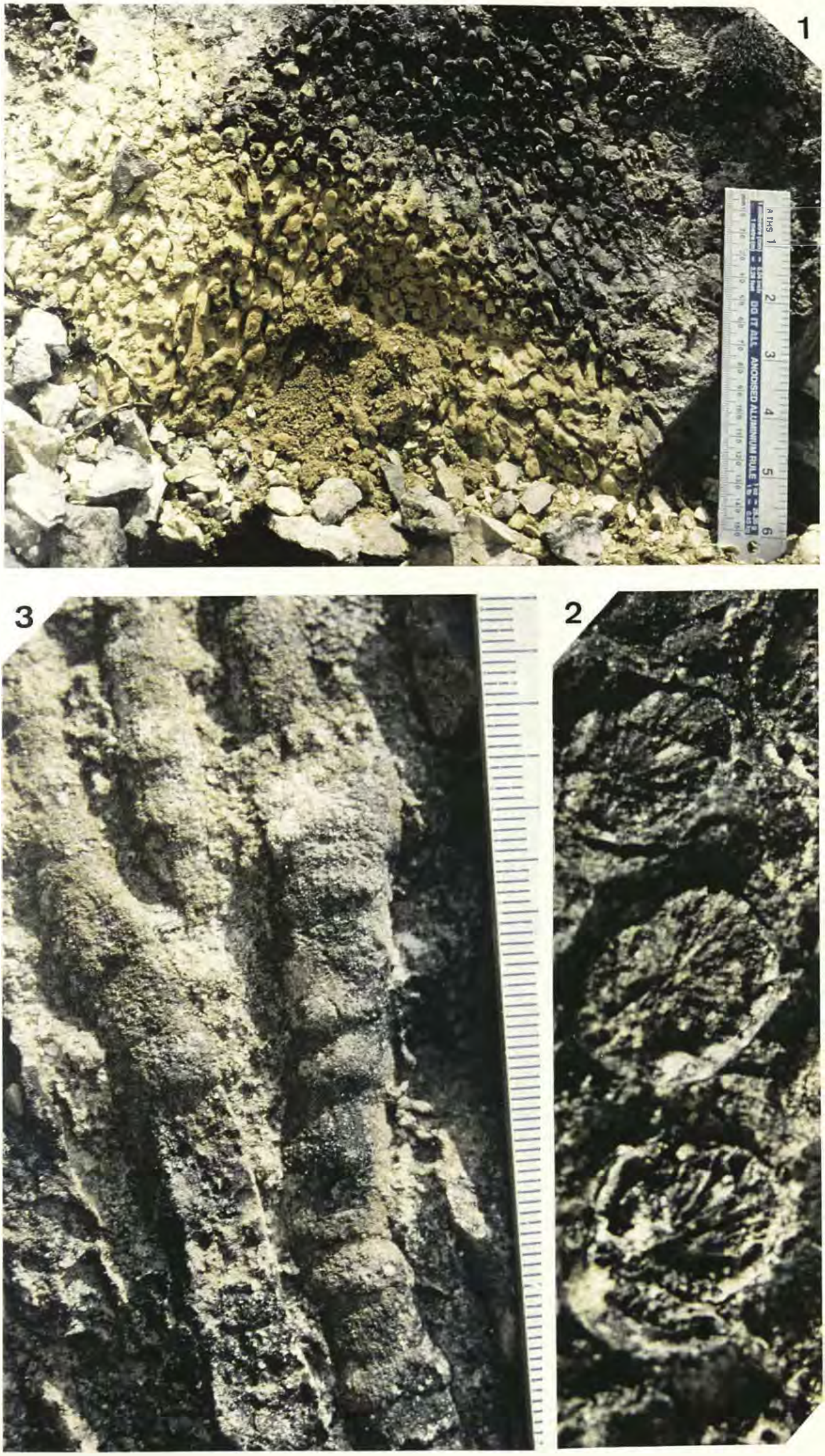
1
3
2
DO IT ALL ANODISED ALUMINIUM RULE

Plate 2.10: Coral fauna; Quatre Pieux section; Complexe récifal supérieur

Figure 1: Details of the calicular structure of *Mitrodendron*. The characteristic features of M*itrodendron* are: the bilateral symmetry of the septal insertion; relatively large pockets surrounded by large vesicular dissepiments on the inner edge of the corallite wall; and the presence of a main septum which is much thicker and longer than the other septa. Width of frame 3 inches.

Figure 2: Thin encrusting, foliaceous forms of *Microsolena*. Note the domal crusts on some of the corals. Height of frame 3 inches.

Figure 3: ?Soleporacean algae encrusting stylinid. Height of frame 2 inches.

All figures are negative prints from thin sections.

1

2

3

Plate 2.11: Reef outcrop and facies of the Bois du Parc section; Complexe récifal supérieur

Figure 1: The Bois du Parc section. Height of section approximately 40 m. Note lack of internal architecture (the fractures at the top of the outcrop are not accessible and are believed to be post-depositional).

Figures 2-3: Geopetal fills are common throughout the intra-reef sediment and are a consequence of the extremely early cementation of the sediment. Two types are present: infilling of voids left by early dissolution of branching phaceloid coral (1); and infilling of boring bivalves (2). Also note the dense creamy nature of the intra-reef sediment which is a microbial biopelmicrite identical to that found at Quatre Pieux.

Figure 4: Platy *Isastraea* coral encrusted by algae.

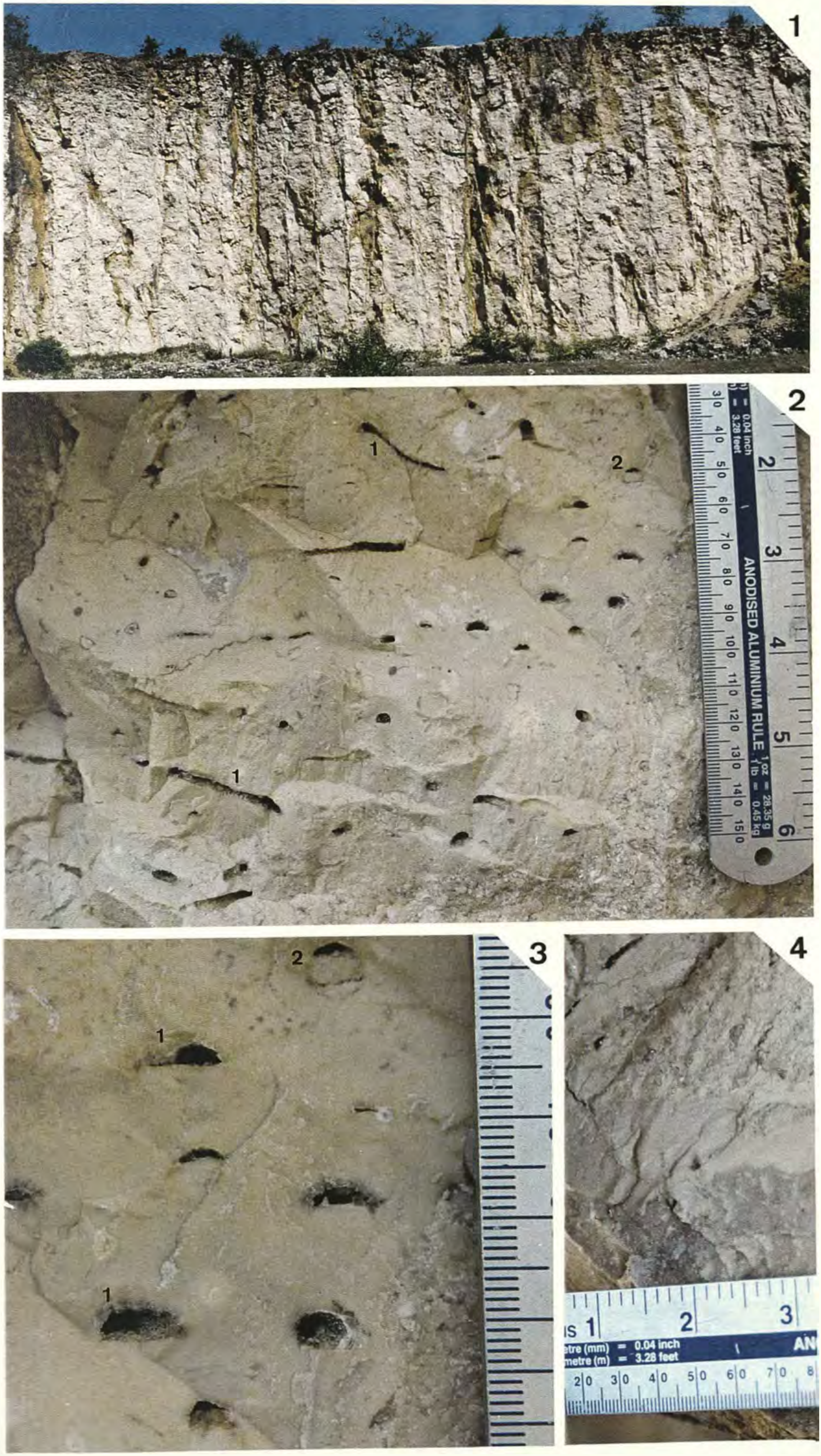
1
2
3
4
ANODISED ALUMINIUM RULE
= 0.04 inch
= 3.28 feet
1oz = 28.35 g
1lb = 0.45 kg
etre (mm) = 0.04 inch
metre (m) = 3.28 feet

Plate 2.12: Microfacies and fabric of the Bois du Parc section; Complexe récifal supérieur

Figures 1-2: Figure 1, general microfabric of the intra-reef sediment. Note the importance of laminated peloidal fabrics and their rapid development over the biointrasparites (just below the well developed laminated fabric). Also characteristic of these sediments is the immature nature of the bioclasts; height of frame 2.7 inches. Figure 2, details of the laminated fabric shown in figure 1. Both figures are negative prints from thin sections.


1

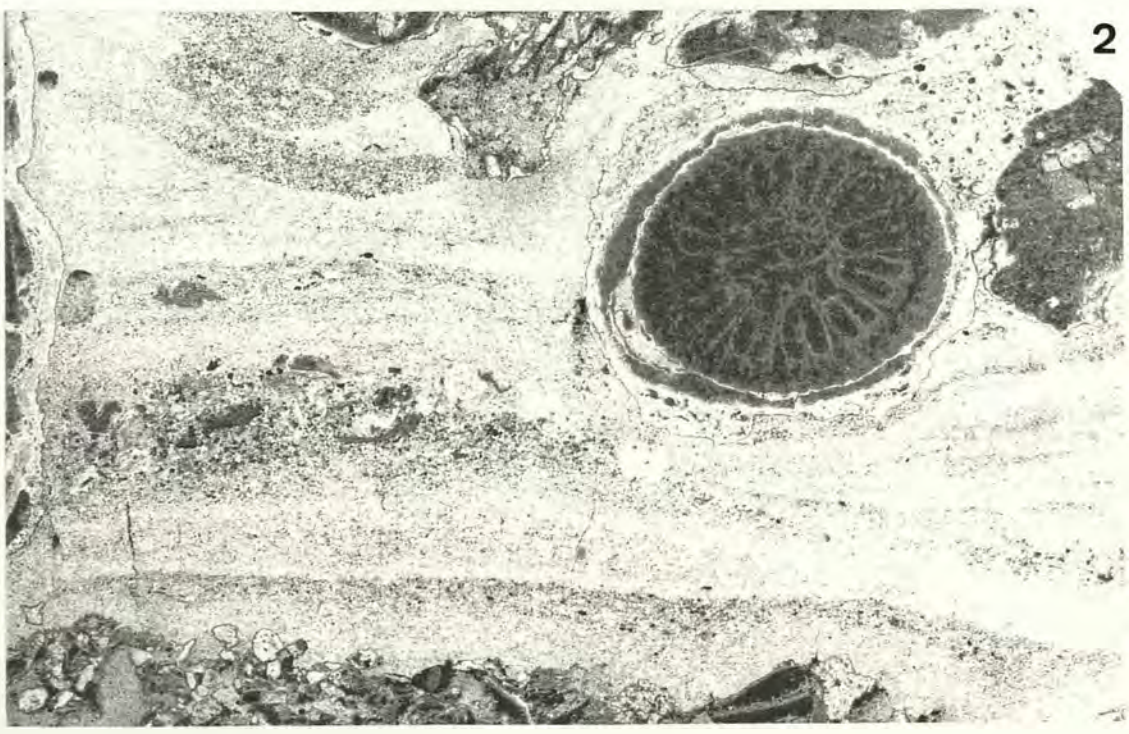
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Plate 2.13: Microfacies and fabric of the Bois du Parc section; Complexe récifal supérieur

Figure 1: General figure showing the microfabric of the reef which can be rich in algae and ?calcified cyanobacteria. It has not been possible to establish with confidence whether the organism to the lower right of figure 1 (marked by the arrow) is algal or calcified cyanobacterial. Height of frame 3 inches.

Figure 2: Details of the organism encrusting the two *Stylosmilia* branches in the top center of figure 1. These resemble the calcified cyanobacterial filaments of *Cayeuxia* and therefore these crusts can be referred to as porostromate crusts.

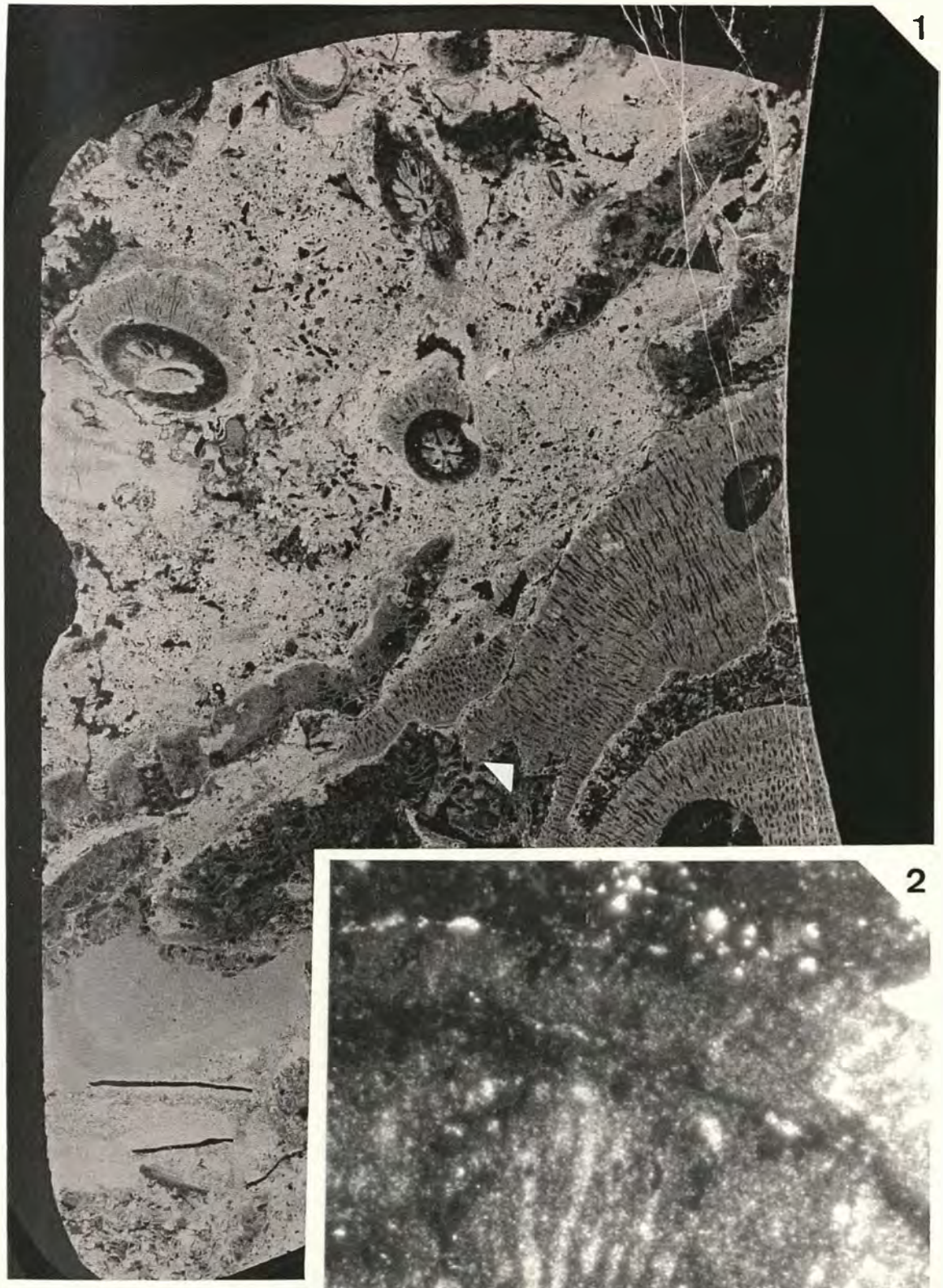
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Plate 2.14: Branching phaceloid coral fauna of the Bois du Parc section; *Dermoseris*; Complexe récifal supérieur

Figures 1-3: *Dermoseris* Colony. Figure 1 shows a 2 m high *Dermoseris* colony which has a dense branch packing density (figure 2). Figure 3: Transverse section through two *Dermoseris* branches showing their calicular details (negative print from thin section). Branch diameter 1.2-1.4 cm.

1

3

2

Plate 2.15: Branching phaceloid coral fauna of the Bois du Parc section; and *Calamophylliopsis Cladophyllia*; Complexe récifal supérieur

Figure 1: A fragmented *Cladophyllia* colony; scale in inches.

Figure 2: Details of the *Cladophyllia* colony in figure 1.

Figure 3: Two intergrowing *Calamophylliopsis* colonies; height of frame 1.2 m.

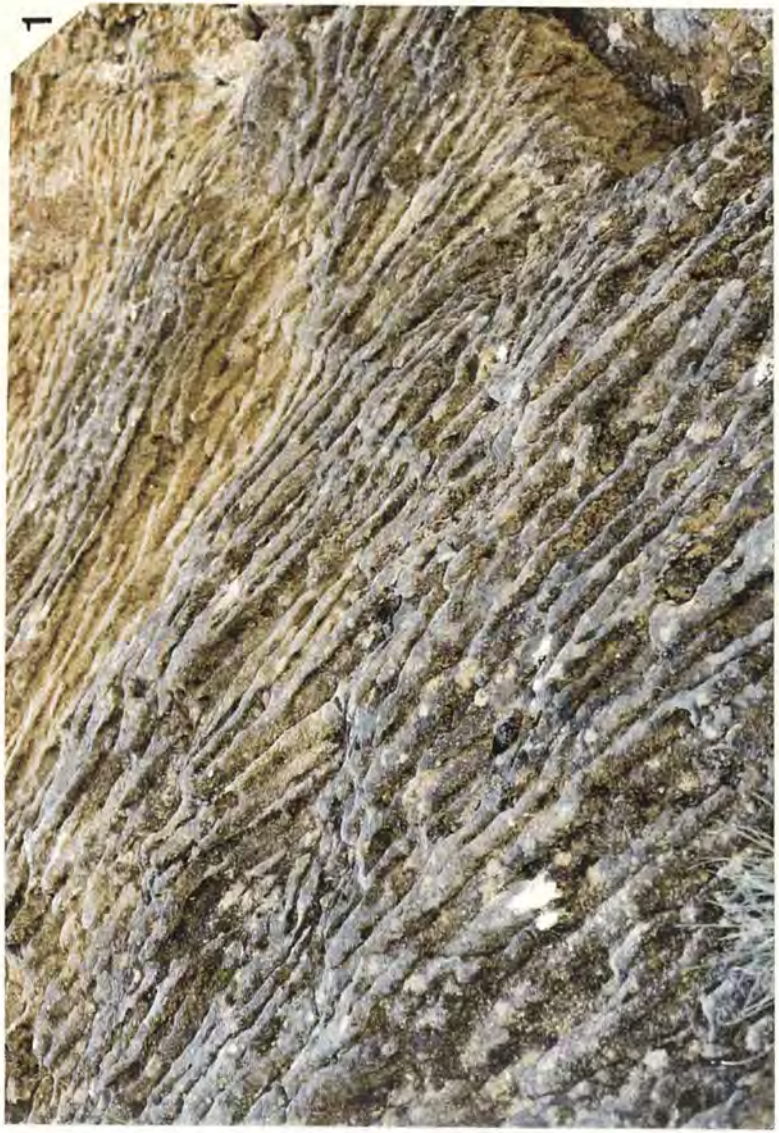
1

3

2

Plate 2.16: Branching ramose coral fauna of the Bois du Parc section; Complexe récifal supérieur

Figures 1-3: Very large branching ramose colonies are a major contributor to framework construction and develop as large, dense thickets with closely spaced parallel branches. Figure 1, ?*Thamnasteria* which was over 4 m across; figure 2 m across. Figure 2, Branching ramose microsolenid; figure 3: branching ramose stylinid (*Pseudocoenia limbata*). Half the hammer head showing is 7 cm across.




ANODISED ALUMINIUM RULE

Plate 2.17: Sub-branching ramose and massive corals; Bois du Parc section; Complexe récifal supérieur

Figures 1-2: This colony of *Pseudocoenia* appears to have developed a knobby surface and sprouted stout branches (sub-branching ramose growth form). Various coral growth forms can be observed from corals with knobby top surfaces to corals with well developed branches (i.e. plate 2.16-fig 3). Figure 2, details of the top of one of the branches in figure 1 showing the divergent "up and out" corallite growth typical of most branching ramose colonies.

Figure 3: The massive colony on the left of the figure is a domal form of *Pseudocoenia* with a very similar (?identical) calicular structure to that of the sub-branching ramose *Pseudocoenia* in figures 1-2. The branching phaceloid colony on right is a *Calamophylliopsis*. Note very high coral skeletal biovolume.


1
LUMOCOLOR
non-permanent
316

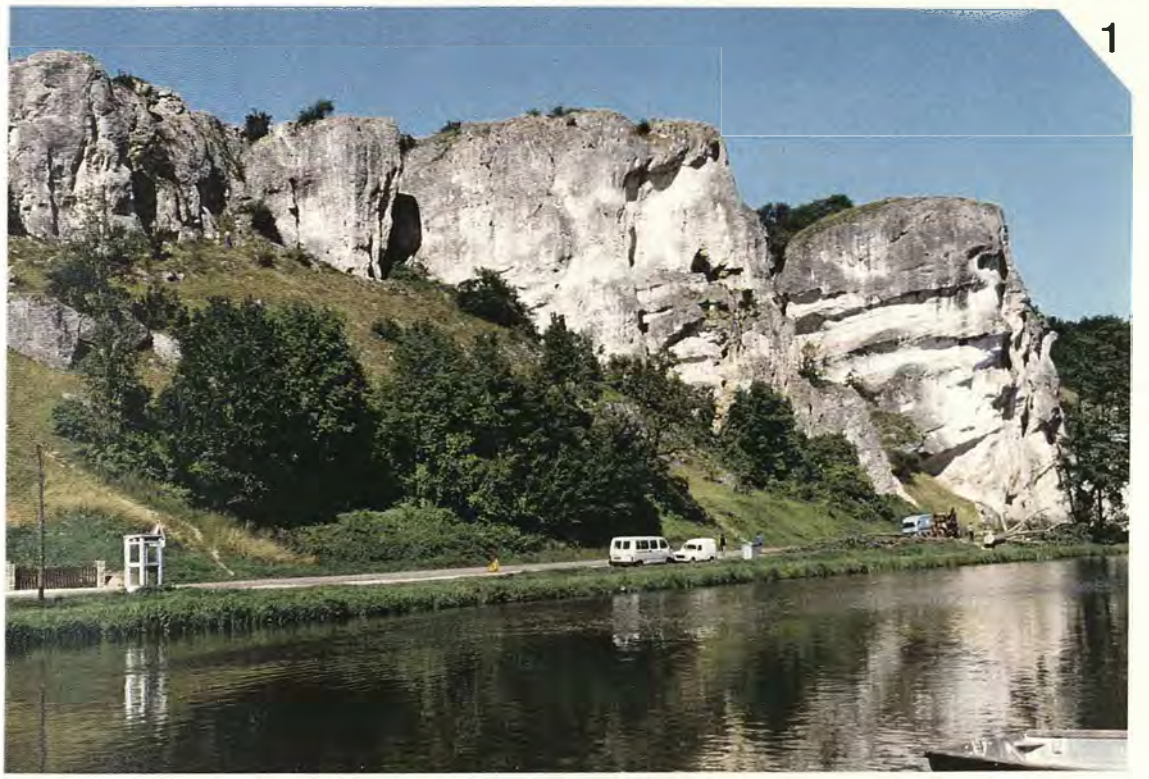

2


3

Plate 2.18: General view of the Rochers du Saussois section and reefal structure; Complexe récifal supérieur

Figure 1: Rochers du Saussois section looking northeast across the Yonne.

Figures 2-3: Details of the "corrugated" structure of the reefal unit. The resistant (concave) bands have a well developed framework with high coral skeletal biovolumes (A). The concave bands have very poorly developed framework with very low coral skeletal biovolumes (B). Often these framework poor bands are bioclastic piles with very little framework development. The massive band at the top of the outcrop has a high concentration of *Stylina* and *Pseudocoenia* and the microfacies suggests a slightly higher energy environment than the rest of the unit.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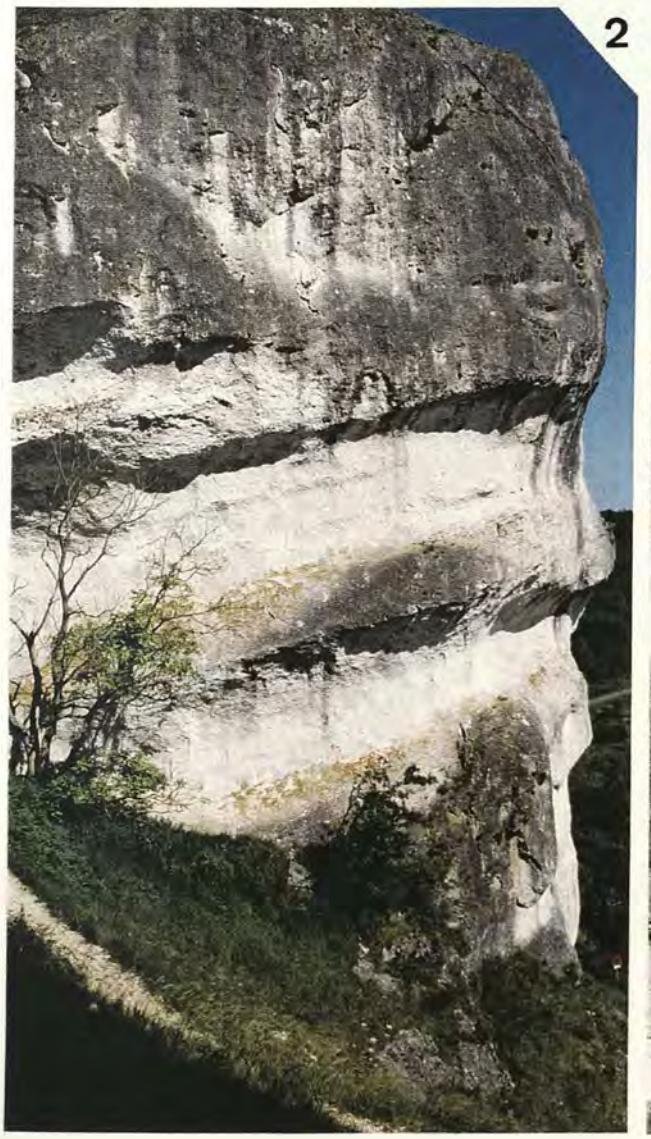
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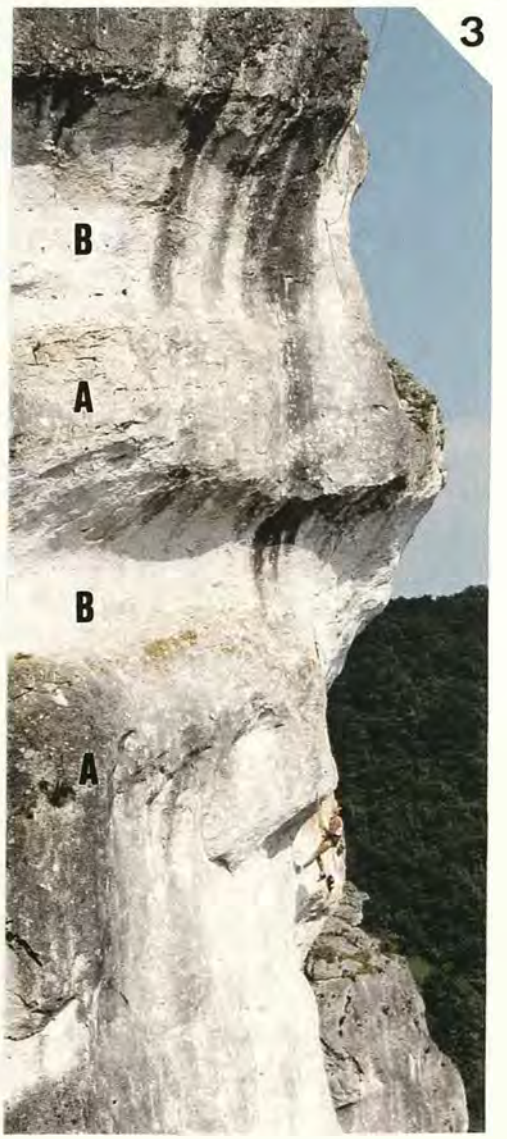

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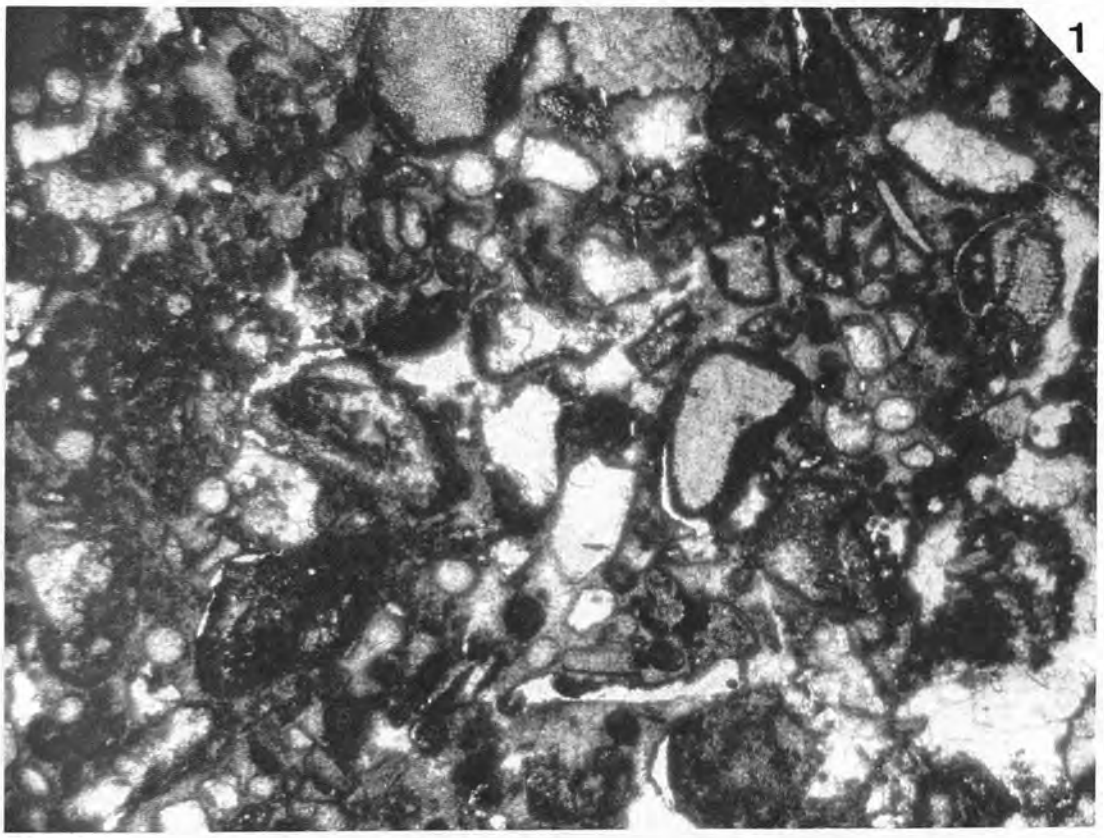
Plate 2.19: Intra-reef sediment microfacies; Saussois section; Complexe récifal supérieur

Figures 1-2: Microfacies of the intra-reef sediment of the Saussois reef. These are generally biomicrites (figure 1) to poorly washed biosparites (figure 2). Note the highly micritized nature of the grains and the well developed spongiostromate coatings. Both these features suggest that the bioclasts had a high residence time on the sediment surface. Height of frame 4 mm.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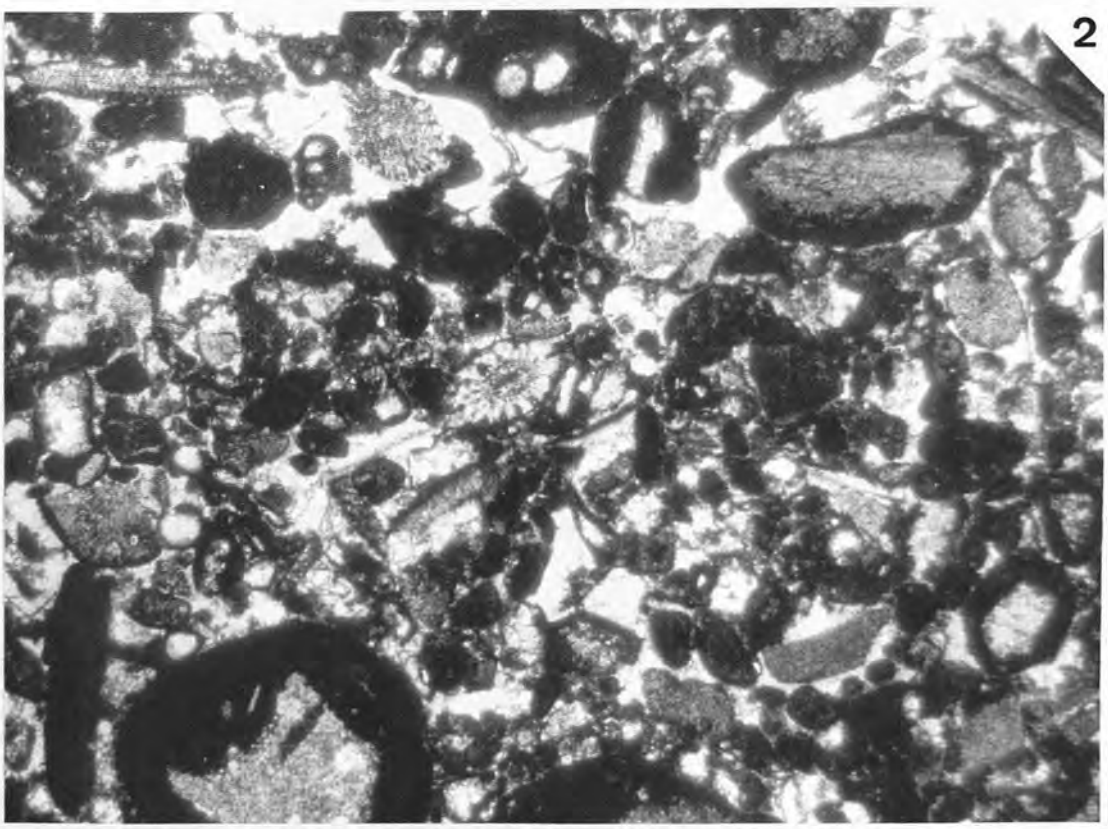
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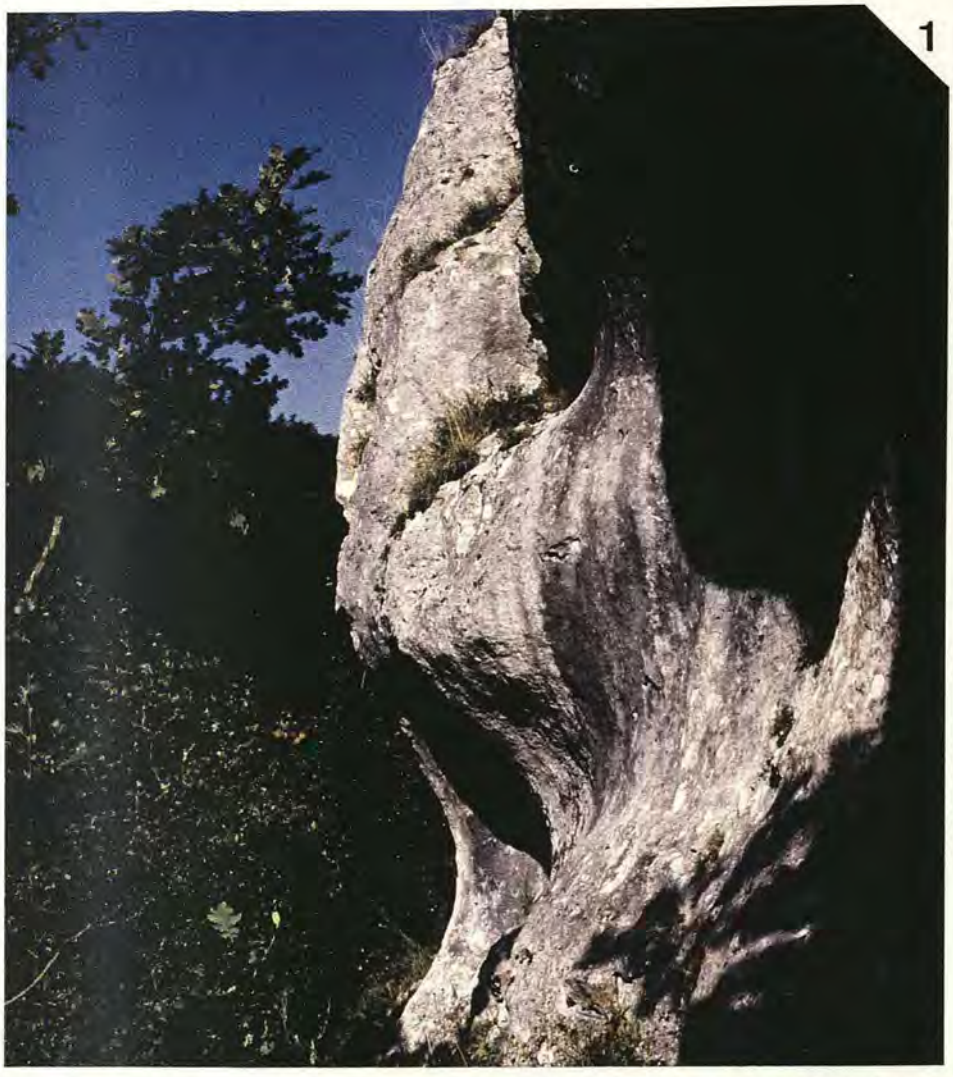
Plate 2.20: Rocher aux Poulets section; Complexe récifal supérieur

Figure 1: Reefal unit showing the "corrugated" structure; height of frame 5 m.

Figure 2: Truncation of an *Aplosmilia* colony by a channel during a storm event; hammer 32 cm.



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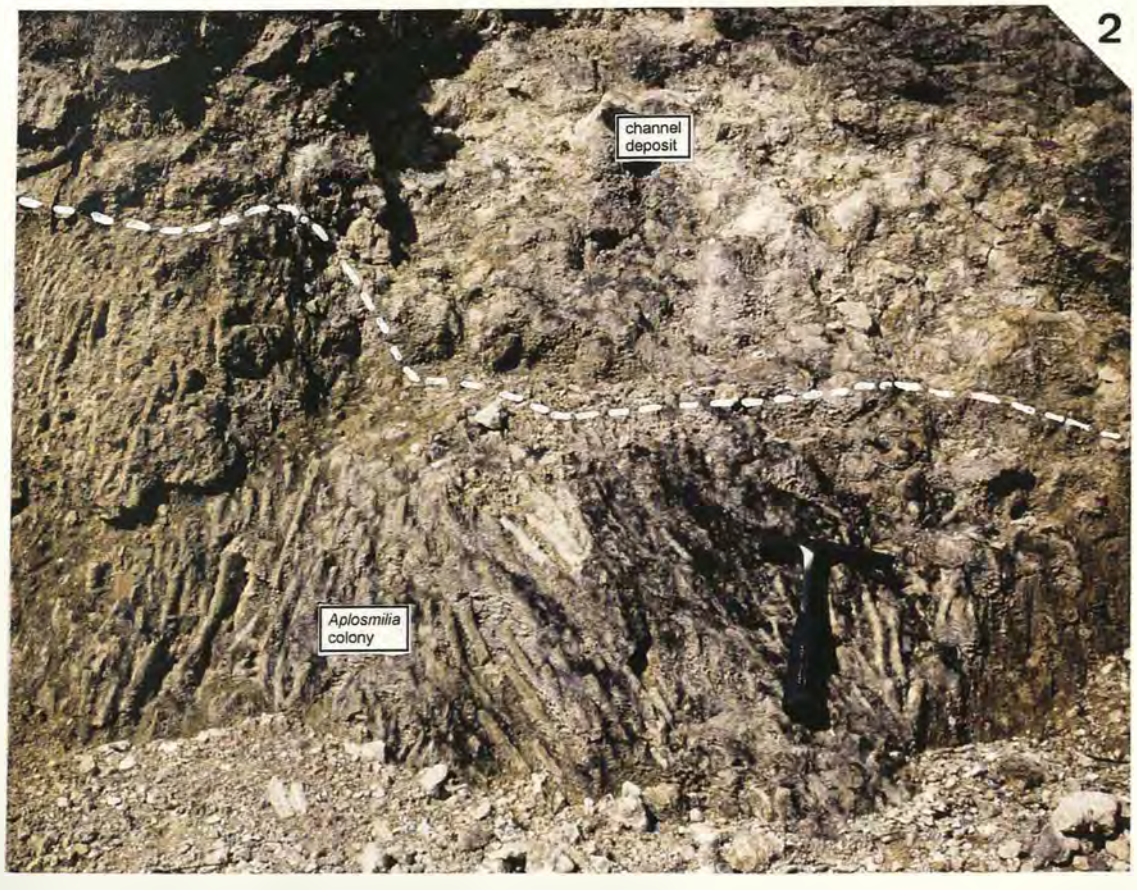
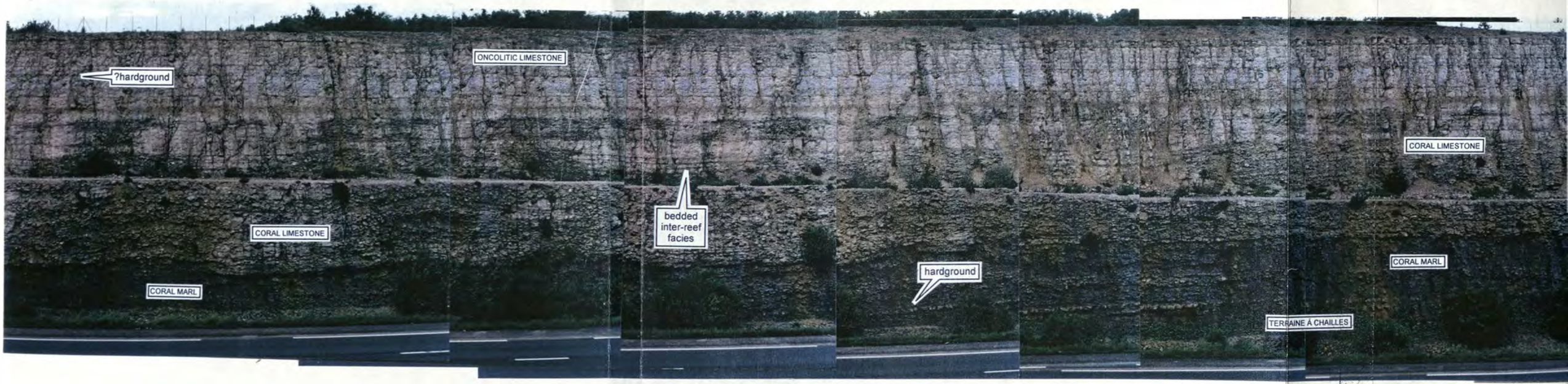


2

Plate 3.1: Photomontage of the Foug section showing the succession and distribution of facies; lower reef complex.

Figure 1: Note the sharp boundary between the coral marl and the coral limestone and the development of small reefal mound within the coral limestone, particularly to the centre left of the plate. Boundaries between units marked by arrows; field of view approximately 350 m.


?hardground
ONCOLITIC LIMESTONE
CORAL LIMESTONE
CORAL MARL
bedded inter-reef facies
hardground
CORAL LIMESTONE
CORAL MARL
TERRAINE À CHAILLES


ONCOLITIC LIMESTONE
CORAL LIMESTONE
CORAL MARL
hardground
CORAL LIMESTONE
CORAL MARL
TERRAINE Á CHAILLES

1

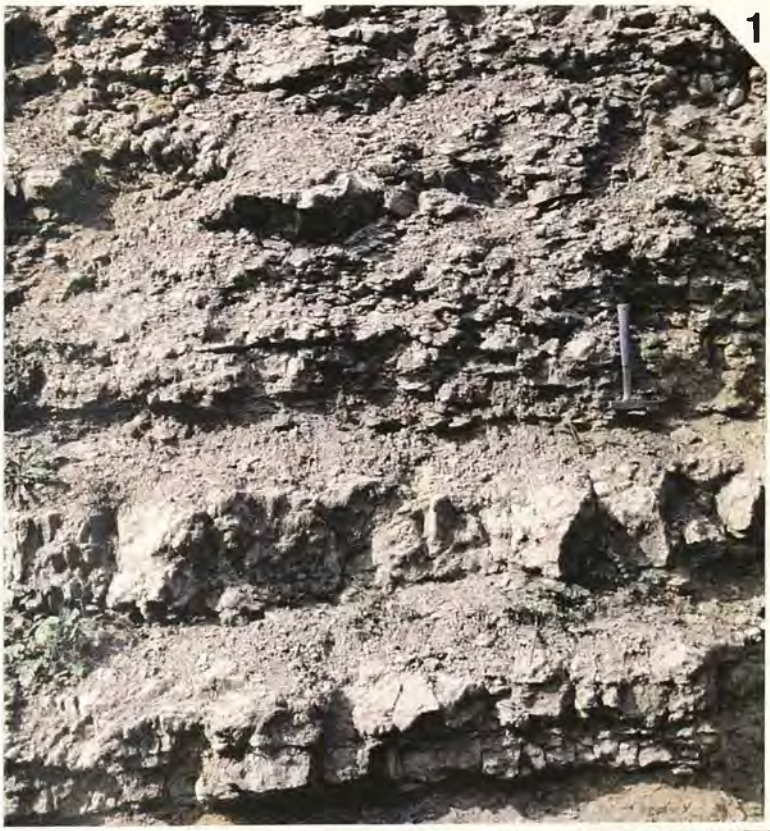
Plate 3.2: Facies and fabric of the coral marl at Foug; lower reef complex.

Figure 1: Details of the oyster hardground marking the boundary between the Terraine à Chailles and the coral marl (the first coral bed in the sequence). Corals are virtually absent in the Terraine à Chailles, yet a few centimetres above the conformable boundary they form the majority of the facies (figure 2). Hammer 32 cm.

Figure 2: Details of the coral fabric in the coral marl. Note the extremely high coral skeletal biovolume which approaches 70%. Hammer 32 cm.

Figure 3: Coral growth forms in the coral marl which is dominated by platy to tabular forms. Hammer head 19 cm.

Nearly all the corals identifiable in these figures are microsolenids.



1

CORAL MARL

hardground

TERRAINE À CHAILLES

2

3

Plate 3.3: Lower and upper boundary of the coral marl at Foug; lower reef complex.

Figures 1-2: Top (figure 1) and bottom (figure 2) view of the oyster *Deltoideum delta* which forms the hardground boundary between the Terraine à Chailles and the coral marl. Note the strong degree of polarisation of the encrusting fauna which is concentrated on the bottom surface of the valve. This faunal polarisation also occurs on the coral plate in the coral marl above. Scale in centimetres.

Figures 3-4: Boundary between the coral marl and the coral limestone. Note the very clear distinction between the two coral units which is mainly a result of the marked reduction in siliciclastics in the coral limestone. Height of frames 2.5 m.


1


2


3
coral limestone
coral marl


4

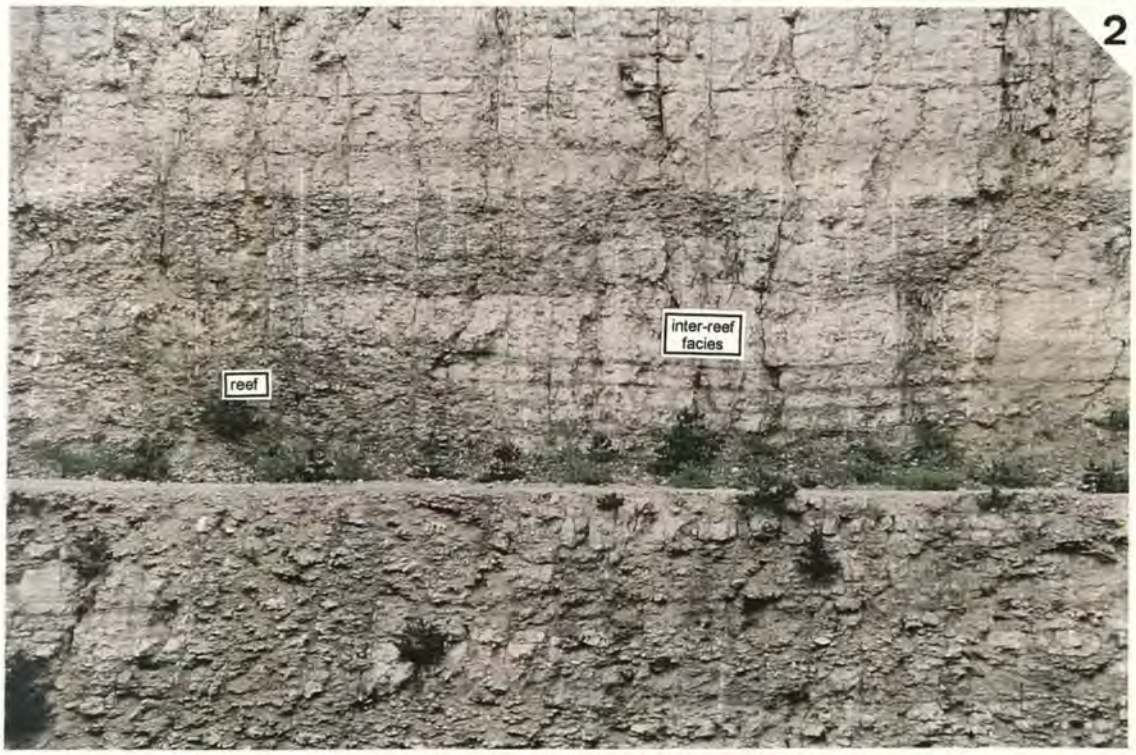
Plate 3.4: Framework and reefal fabric of the coral limestone at Foug; lower reef complex.

Figure 1: Relatively large reefal development flanked laterally by bedded inter-reef bioclastic packstones. Height of frame 8 m.

Figure 2: Small isolated reefal mounds. Note the lateral transition from reef facies to well bedded inter-reef facies in the centre of the figure. Height of frame 9 m.

Figure 3: Details of the coral framework of the coral limestone. Hammer 32 cm.


1
inter-reef facies
reef framework

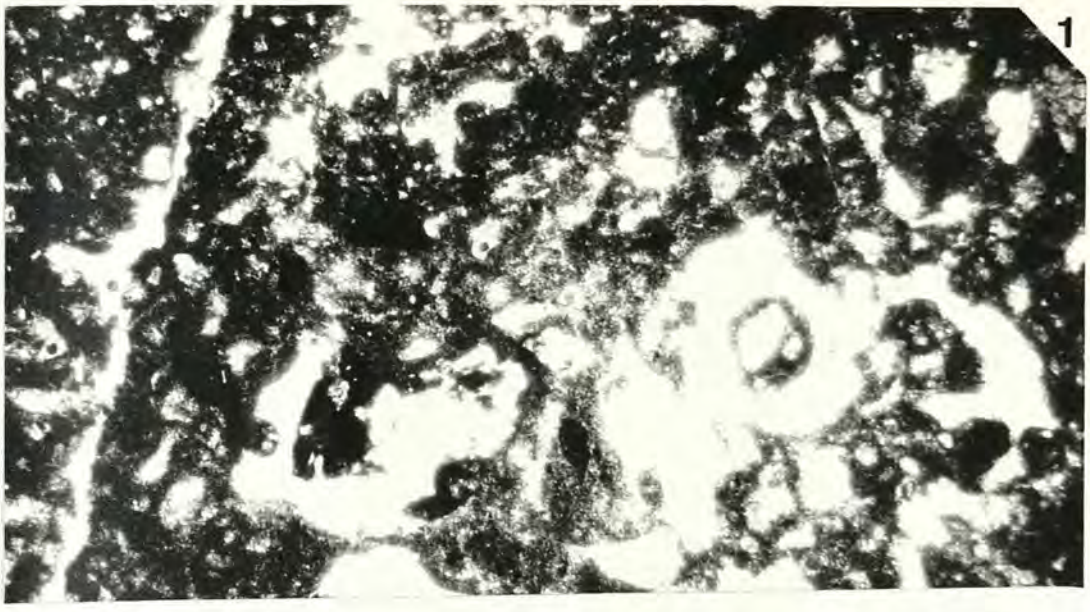

2
inter-reef facies
reef


3

Plate 3.5: Microfacies of the intra-reef sediments and corals of the reefal units; lower reef complex.

Figures 1-2: The intra-reef sediments are dominated by bioclastic packstones and wackestones (biomicrites). Note the abundance of bioclastic material (mainly coral) and the very immature nature of the allochems. Height of frames: figure 1, 2.4 mm; figure 2, 2.5 mm.

Figure 3: Transverse section through the branching ramose *Dendraraea*. Width of frame: 3 cm. (Negative print from thin section).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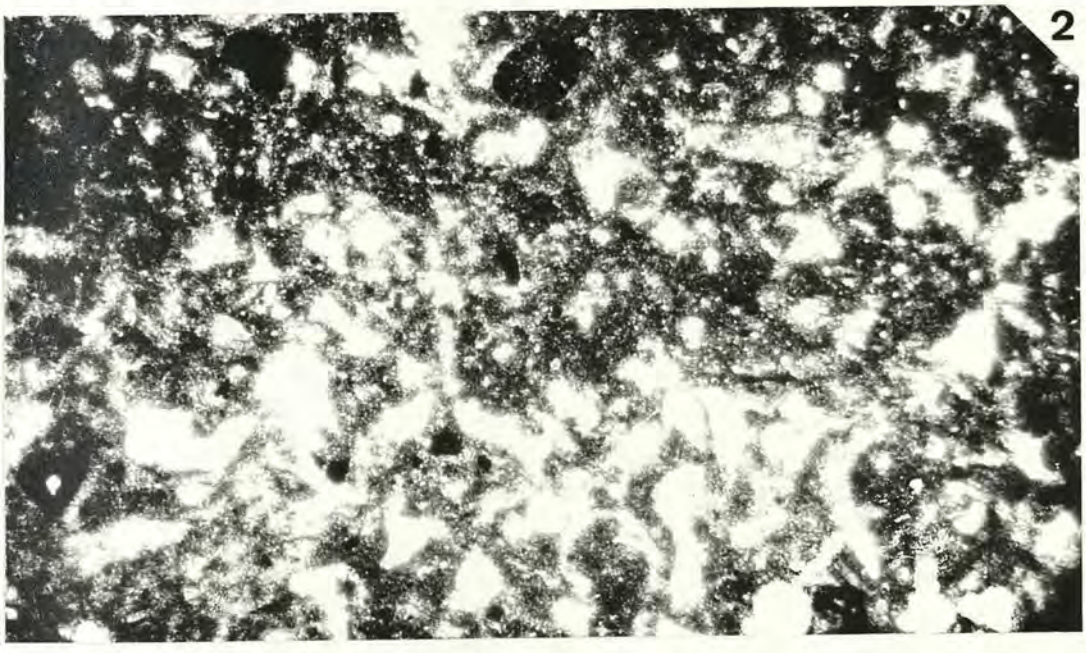
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Plate 3.6: Boring fauna; Foug; lower reef complex.

Figure 1: Bored and encrusted bottom surface of one of the oysters shown in plate 3.3 figures 1-2.

Figure 2: Bored top surface of the microsolenid *Comoseris* from the coral marl. The organism probably responsible for these borings is the bivalve *Lithophaga*.

Figure 3: *Entobia* borings in an unidentifiable microsolenid from the coral limestone.

Scale in all figures in centimetres.


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Plate 3.7: Facies and reef fabric of the reefal unit at Pagny-sur-Meuse; upper reef complex.

Figure 1: General view of the outcrop where the reefal thicket can be observed. Note the very fine chalky nature of the intra-reef sediments and the vague planar bedding surfaces. This feature is very subtle and only observable when the sun is at its highest during the mid afternoon. Bernard Lathuilière for scale.

Figures 2-3: Figure 1: Details of the reefal fabric which is dominated by thickets of the branching phaceloid coral *Aplosmilia*; hammer 32 cm. Figure 2: Details of one of the *Aplosmilia* colonies showing the very high branch density within the thickets; height of frame 60 cm.

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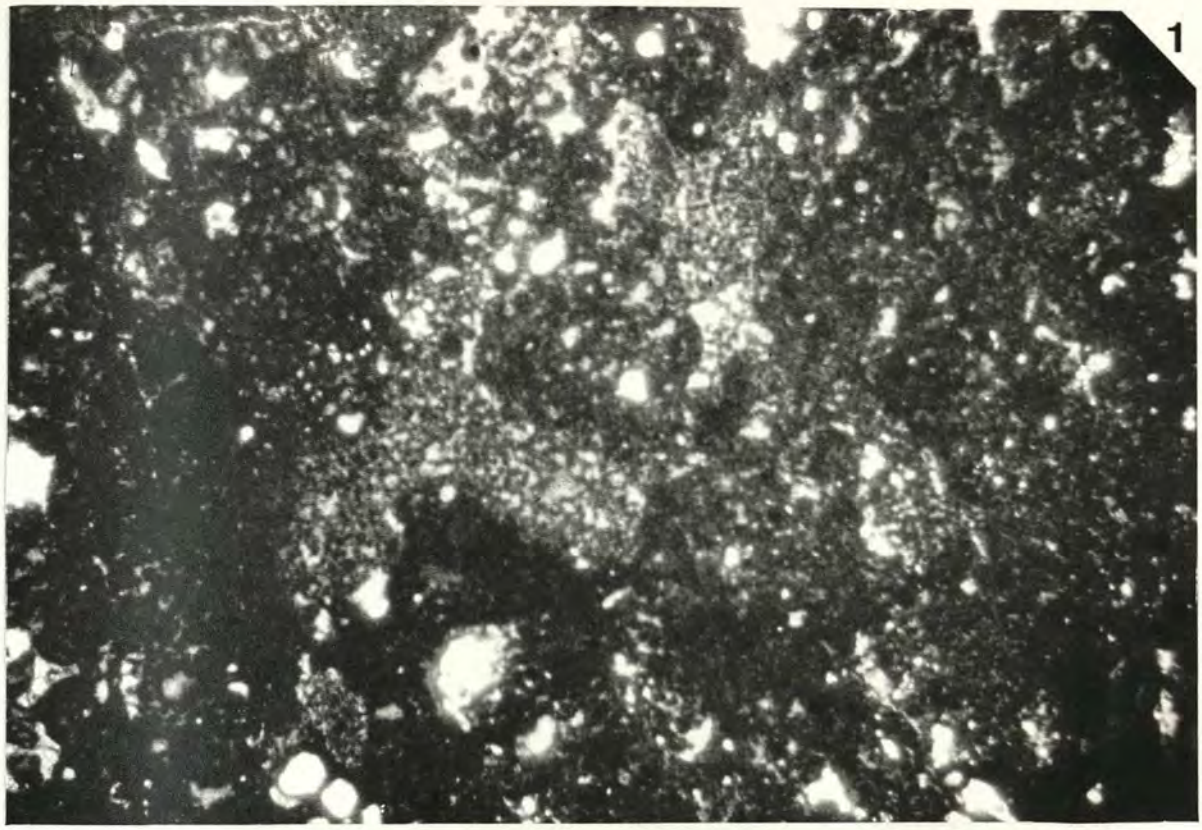
Plate 3.8: Microfacies and fauna of the Pagny reef; Pagny-sur-Meuse; upper reef complex.

Figure 1: Intra-reef sediment microfacies; pelmicrite. Note the blotchy appearance of the fabric and the infilling of ?burrows by peloids. Height of frame: 4 mm.

Figure 2: A phaceloid branch bored by forams and encrusted by problematic chambered organisms. Height of frame: 2.4 mm.

Figure 3: Details of one of the boring forams (cf. *Bullopora*) similar to those shown in figure 2. However in this case It is possible that this particular foram is occupying a pre-existing cavity. Height of frame: 2.4 mm.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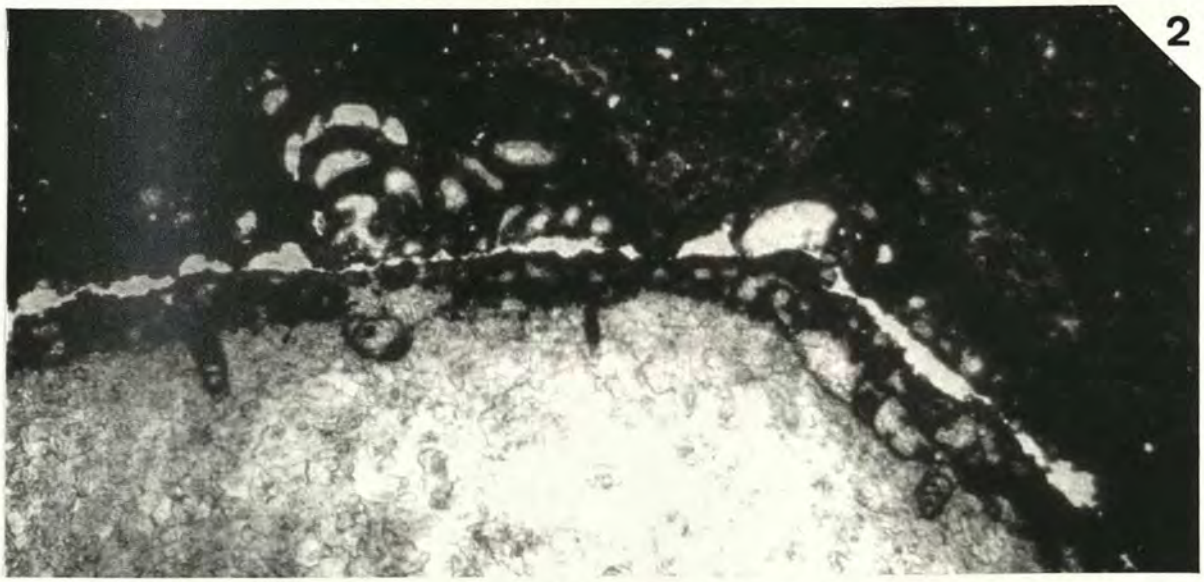
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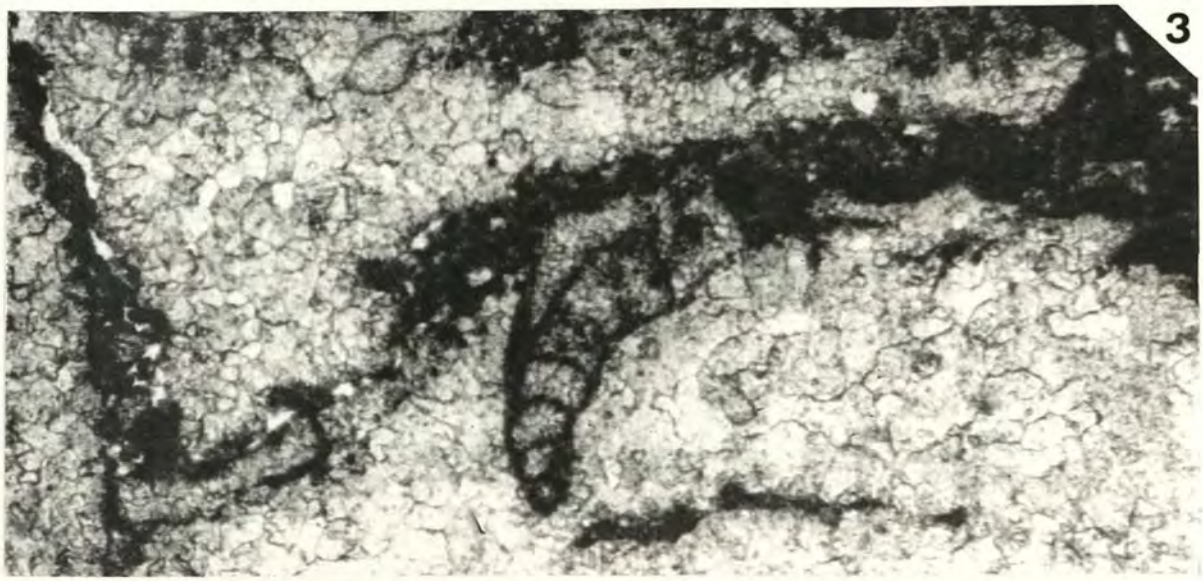
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Plate 3.9: Fauna of the Pagny reef; Pagny-sur-Meuse; upper reef complex.

Figure 1: Fallen block of reef facies showing a colony of the red algae *Solenopora* above which is a colony of the thinly branched coral *Stylosmilia*. Height of frame 50 cm.

Figures 2-3: Although the reefs are dominated by thickets of *Aplosmilia* occasional domal and irregular forms do occur. These are generally stylinids as they are in these two figures. Note the large size of the colony in figure 2 which is 1.7 m high (colony outlined in pen). The hammer in figure 3 is 32 cm.

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Plate 3.10: Branching phaceloid corals of the Pagny reef; Pagny-sur-Meuse; upper reef complex.

Figure 1: Transverse section through a *Dermosmilia* colony. Height of frame: 3.7 cm.

Figure 2: Transverse section through a *Pleurosmilia* colony. Inset, details of the calicular structure of one of the branches clearly showing the very characteristic bilateral symmetry of the septal insertion. Height of frame: 4.5 cm.

(Negative prints from thin sections).

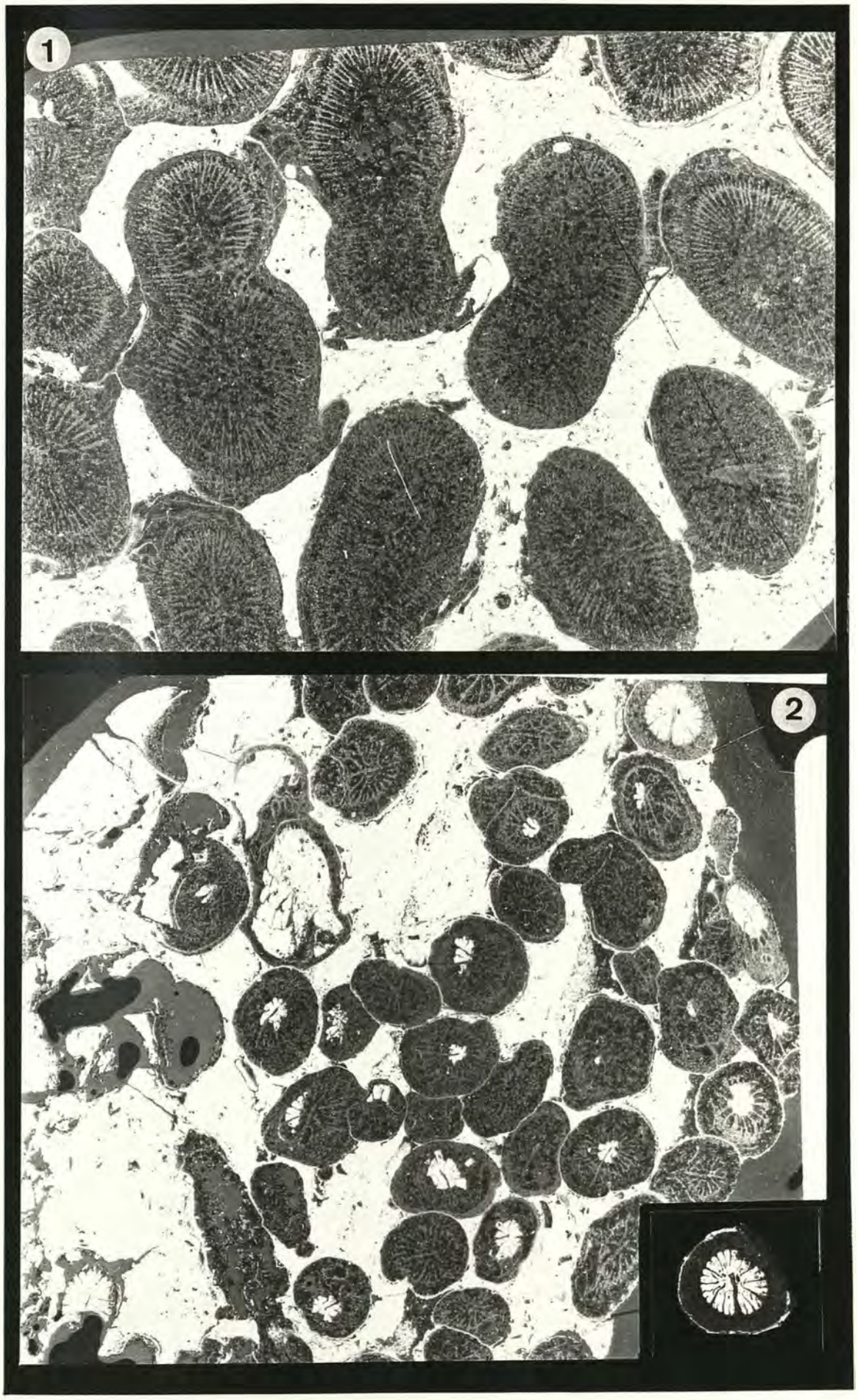
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Plate 3.11: Facies arrangements of the Lérouville section; lower and upper reef complexes.

Figure 1: Photomontage of the section showing the position of the reefal units below and above the crinoidal sandwaves. The whole of the outcrop surface in the foreground of the figure is the palaeosurface of the lower reef complex. Jeep 1.45 m high.

Figure 2: View of the flanks of reef 1 (lower reef complex) illustrating its relatively steep profile. Width of frame in the background about 10 m.

Figure 3: Highly bored surface of the lower hardground which has developed on the upper surface of the lower reef complex. Pen 15 cm.

Figure 4: Ripples of echinoderm-rich bioclastic limestones onlapping the lower reef. Hammer 32 cm.


1
reef 3:
Isastraea
biofacies
reef 2:
Meandraraea
biofacies
crinoidal
grainstone
upper
hardground
lower
hardground
(figure 3)
rippled
surface
(figure 4)
reef 1
lower reef
complex


4


3


2

Plate 3.12: Facies arrangements of the Euville section (Côtillons quarry); lower and upper reef complexes.

Figure 1: Photomontage of the Euville section showing the spatial distribution of facies. The arrangement of facies is essentially like that of Lérouville although here the lateral equivalents of the upper reef complex are lagoonal mud (Calcaires de Creue). Field of view approximately 300 m.

Figure 2: View of the exposed palaeosurface of the lower reef complex revealing numerous sediment slumps and tongues, testament to the steep primary relief at the flanks of the reef. Pen 15 cm.

Figure 3: Section through the lower reef complex at the foot of the reef. Here the reef, which is dominated by platy corals, rests on a unit of coarse bioclastic packstones. Note the thickness of the reef which is very thin (approximately 40 cm). Whether this is because the section is located at the foot of the reef, where it can be expected to wedge out, or whether the whole reef represents a thin carpet of corals over an extensive bioclastic pile, cannot be established. Hammer 32 cm.


1
local reef facies
lagoonal muds
reef 1 lower reef complex
crinoidal grainstone
upper hardground
lower hardground


3


2

Plate 3.13: Reef 2; *Meandraraea* biofacies; Lérouville section; upper reef complex.

Figure 1: General view of the wavy reefal fabric which is dominated by very thin *Meandraraea* plates. Note the very sudden termination of the reef under a unit of coarse bioclastics. Hammer 32 cm.

Figures 2-3: Details of the reef fabric and coral plates that form the reef. Nearly all the coral plates in these two figures are platy *Meandraraea* colonies. Pen in both figures 15 cm.


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3

Plate 3.14: Reef 3; *Isastraea* biofacies; reef outcrop and fabric; Lérouville section; upper reef complex.

Figure 1: General view of the reef outcrop. Note the general dip of the reef facies to the right of the figure. This is probably inherited from the antecedent topography of the crinoidal sandwaves. Field of view 22 m.

Figures 2-3: Details of the reef fabric and corals. Figure 2: Reef fabric dominated by large thick platy and tabular corals; note the extremely high coral skeletal biovolume which is approaching 80%; hammer 32 cm. Figure 3: Details of the coral plates, note their large dimensions and their very high packing density. Pen 15 cm.

Figure 4: *Thamnasteria* colony with a wavy top surface. Width of plate 18 cm.

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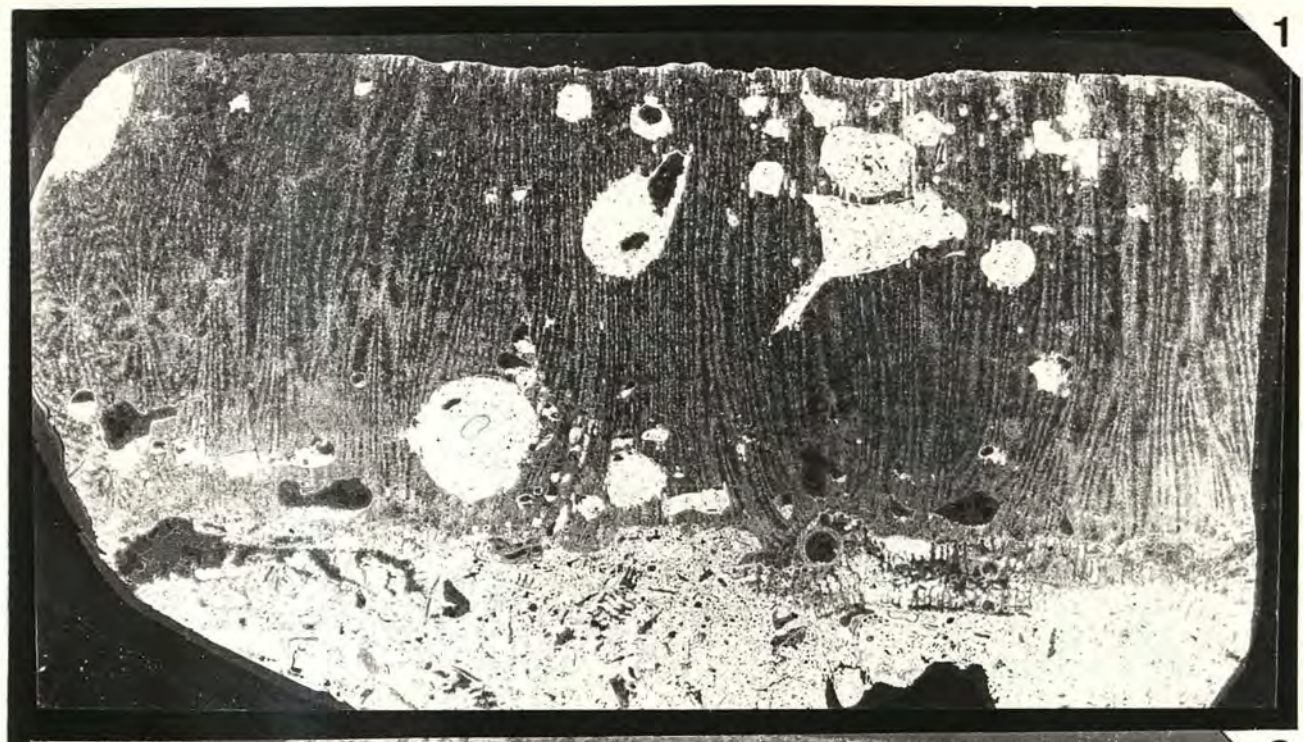
Plate 3.15: Reef 3; *Isastraea* biofacies; reef fauna; Lérouville section; upper reef complex.

Figure 1: Longitudinal section through one of the *Isastraea* colonies showing relatively high degrees of bioerosion. Width of frame: 5.6 cm. (Negative print from thin section).

Figure 2: Transverse section through one of the *Isastraea* colonies showing calicular details. Width of frame: 3.9 cm. (Negative print from thin section).

Figure 3: *Chlamys* valve. Width of frame: 15 cm.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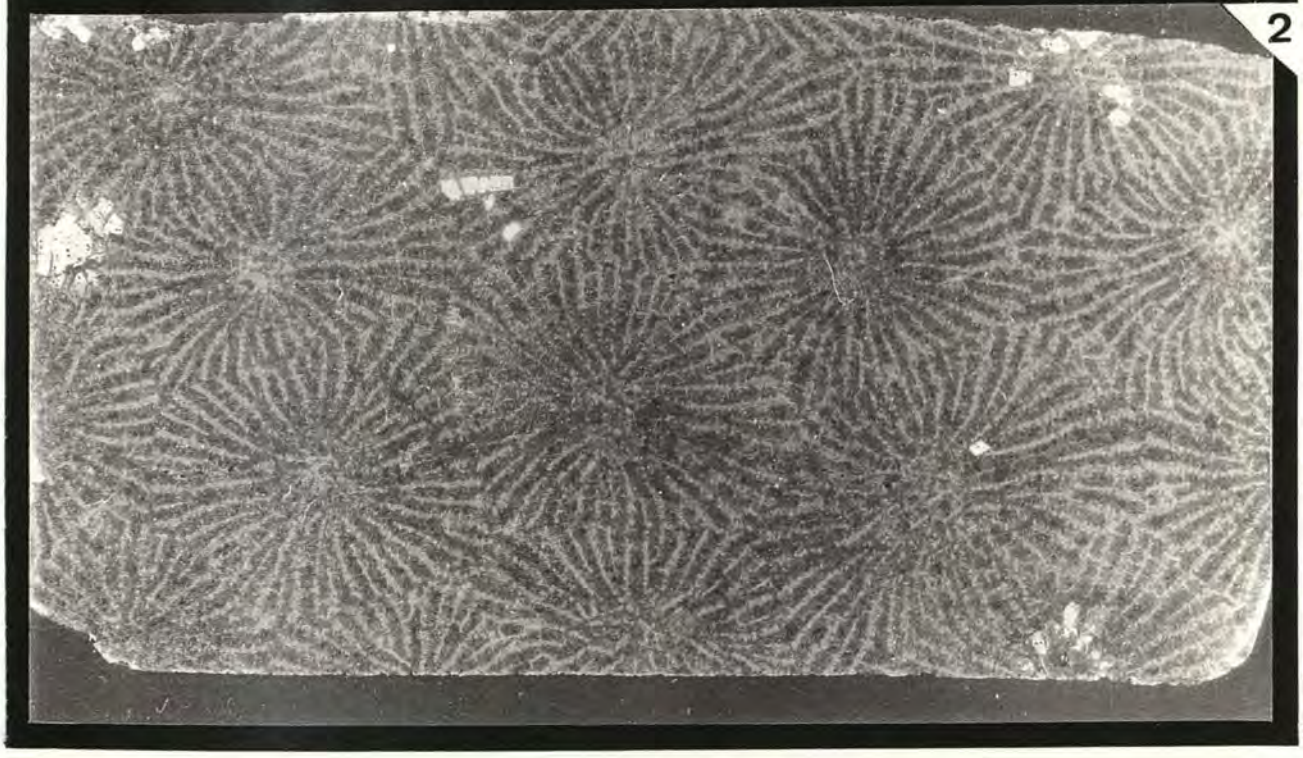
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Plate 3.16: Reef structure and fabric of the St. Mihiel section; upper reef complex.

Figures 1-2: Views of one of the riverside bluffs (bluff 7). Figure 1: Note the development of a corrugated structure within the reefal unit; height of frame 16 m. Figure 2: Details of the corrugated structure shown in figure 1. Height of frame 6 m.

Figure 3: Dense thicket of *Thamnasteria dendroidea* which is a common framebuilder in these reefs. Hammer 32 cm.

Figure 4: Truncation of a *Thamnasteria dendroidea* thicket by storm-deposited debris. Height of frame 45 cm.


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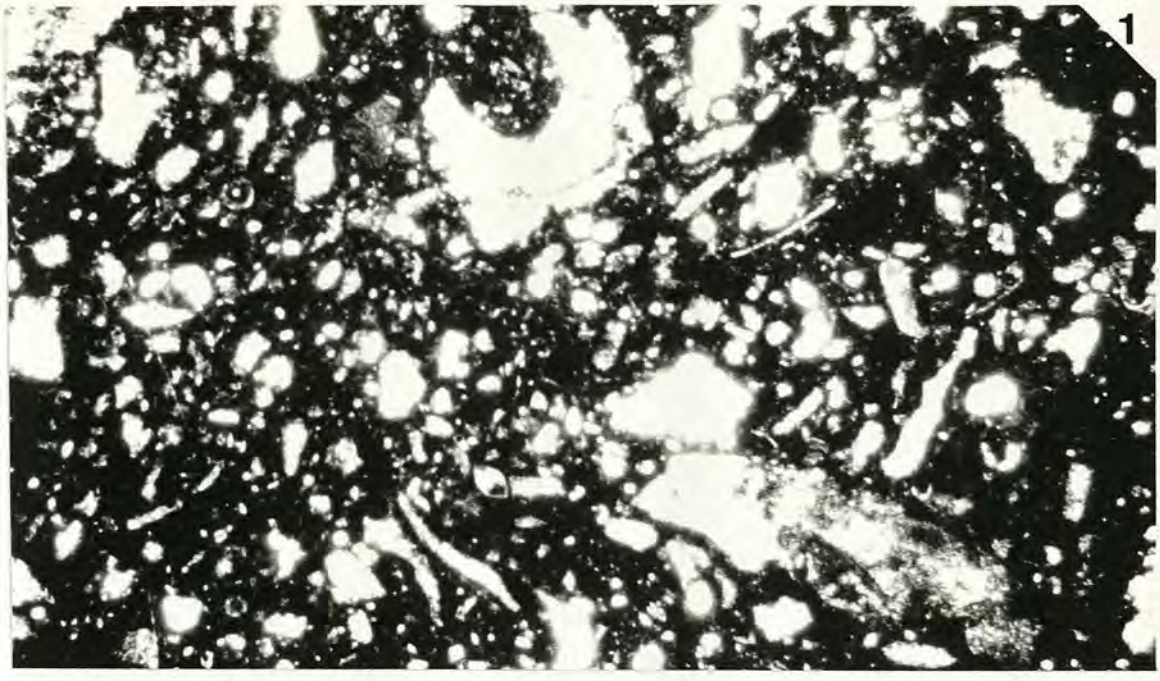
Plate 3.17: Intra-reef sediment microfacies and corals of the St. Mihiel reef; upper reef complex.

Figures 1-2: Intra-reef sediment microfacies. Figure 1: Biomicrite dominated by immature bioclasts predominantly of corals, echinoids and bivalves; height of frames: 3 mm. Figure 2: Poorly washed biosparite - biomicrite with two large micritized echinoderm fragments; height of frames: 3.8 mm.

Figure 3: Transverse section through a *Stylina* colony. Width of frame: 2.3 cm. (Negative print from thin section).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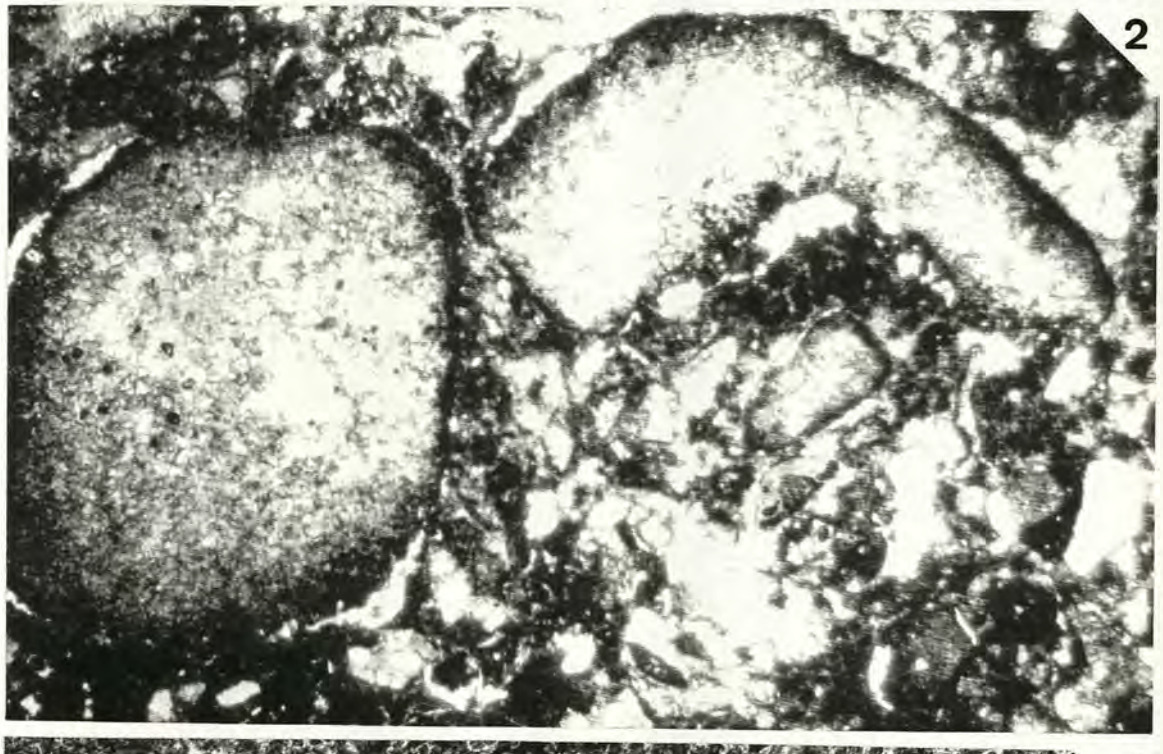
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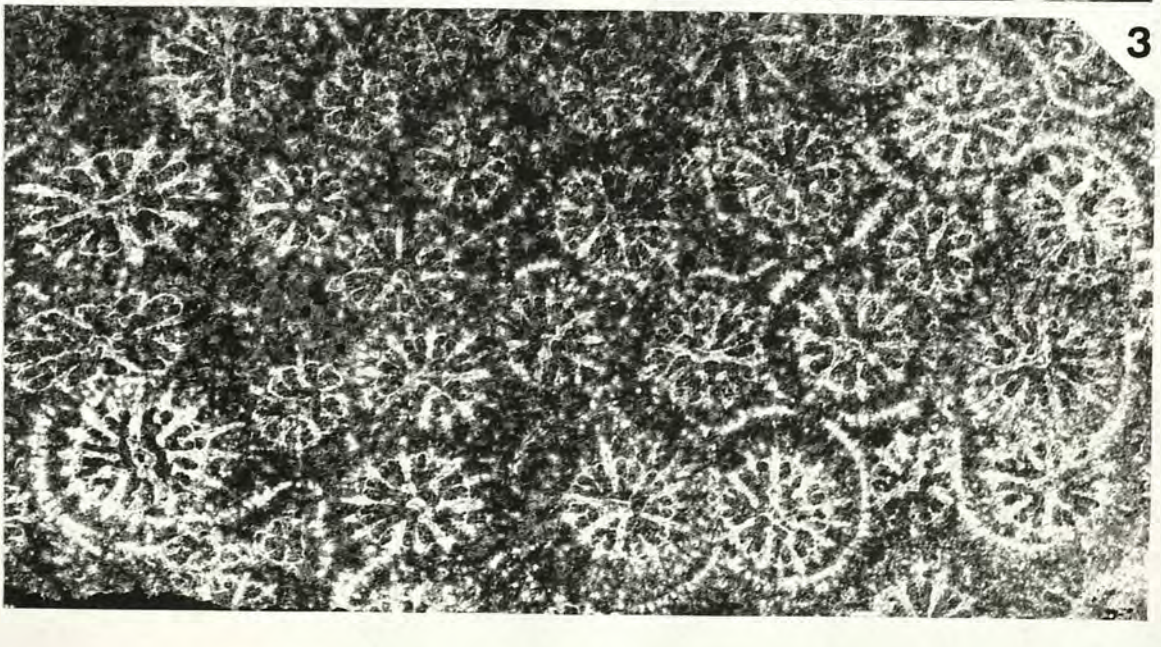
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Plate 3.18: Facies sequence and reef form; Haudainville reefs; upper reef complex.

Figure 1: Figure showing the sequence of facies from crinoidal sandwaves through to reef and post reef bioclastics. The forsets of the crinoidal sandwaves are succeeded by the prograding beds of a coral pavement (see figure 2). Height of frame in the centre of the figure 12 m.

Figure 2: Figure showing the gradational boundary between the topset beds of the crinoidal sandwaves and the ensuing reef, which is initially colonised by domal colonies. Height of frame 2 m.

Figure 3: Domed form build-up onlapped by bioclastic sediments. Height of frame 6 m.


1
bioclastic limestones
reef framework
crinoidal grainstone


2
reef framework
crinoidal grainstone

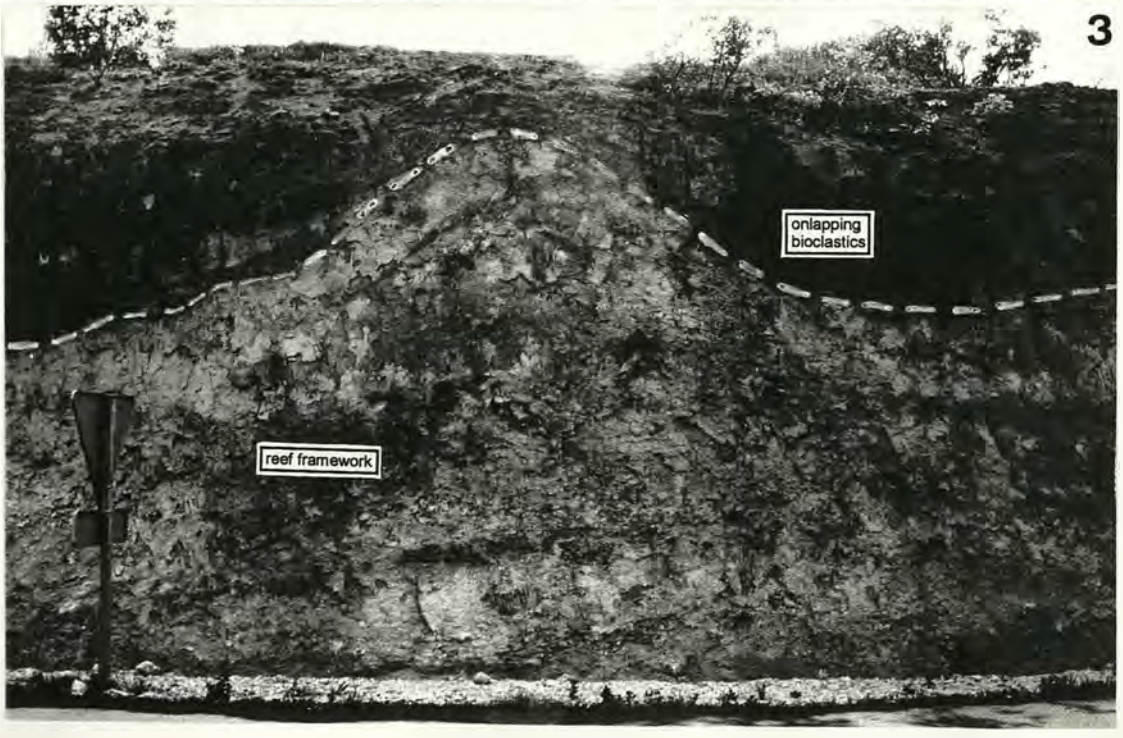
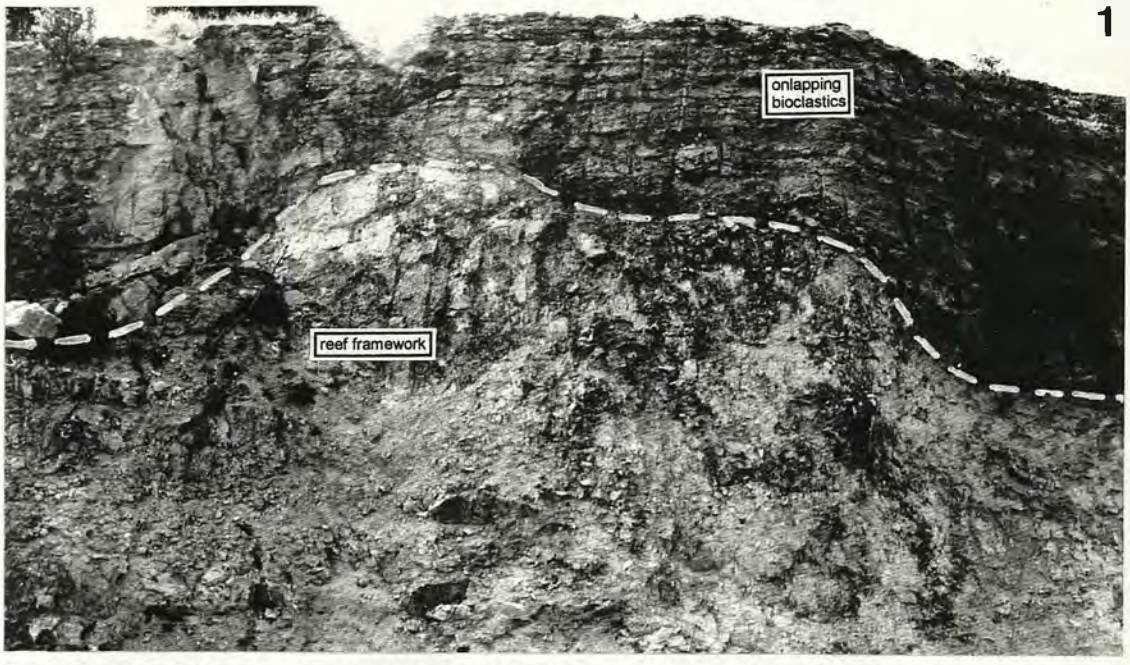

3
onlapping bioclastics
reef framework

Plate 3.19: Reef form and intra-reef sediment microfacies of the Haudainville reefs; upper reef complex.

Figure 1: Domal to tabular build-ups onlapped by well bedded bioclastic sediments. Height of frame 8 m.

Figures 2-3: Intra-reef microfacies. Figure 1: Coarse grained biosparite with well coated bioclasts and peloidal intraclasts; height of frames: 3 mm. Figure 2: Poorly washed biosparite dominated by peloidal intraclasts and bioclastic material; height of frames: 2.4 mm.



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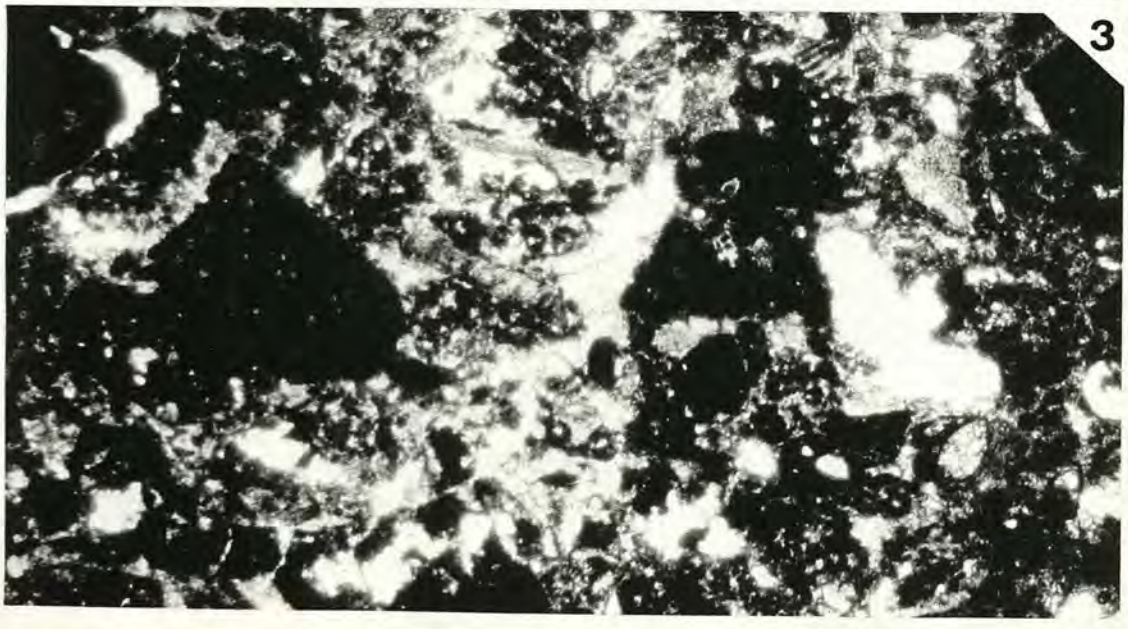

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Plate 3.20: Intra-reef sediment microfacies and fauna of the Haudainville reefs; upper reef complex.

Figure 1: Intra-reef microfacies. Biomicrite dominated by immature skeletal debris. Height of frame: 5.5 mm

Figure 2: A columnar colony of *Solenopora*. Scale in millimetres.

Figure 3: Transverse section through a *Calamophylliopsis* colony. Note the development of spongiostromate crusts (light grey) on a number of the coral branches. Presumably these developed after the colony had been toppled over. Width of frame: 4.4 cm. (Negative print from thin section)

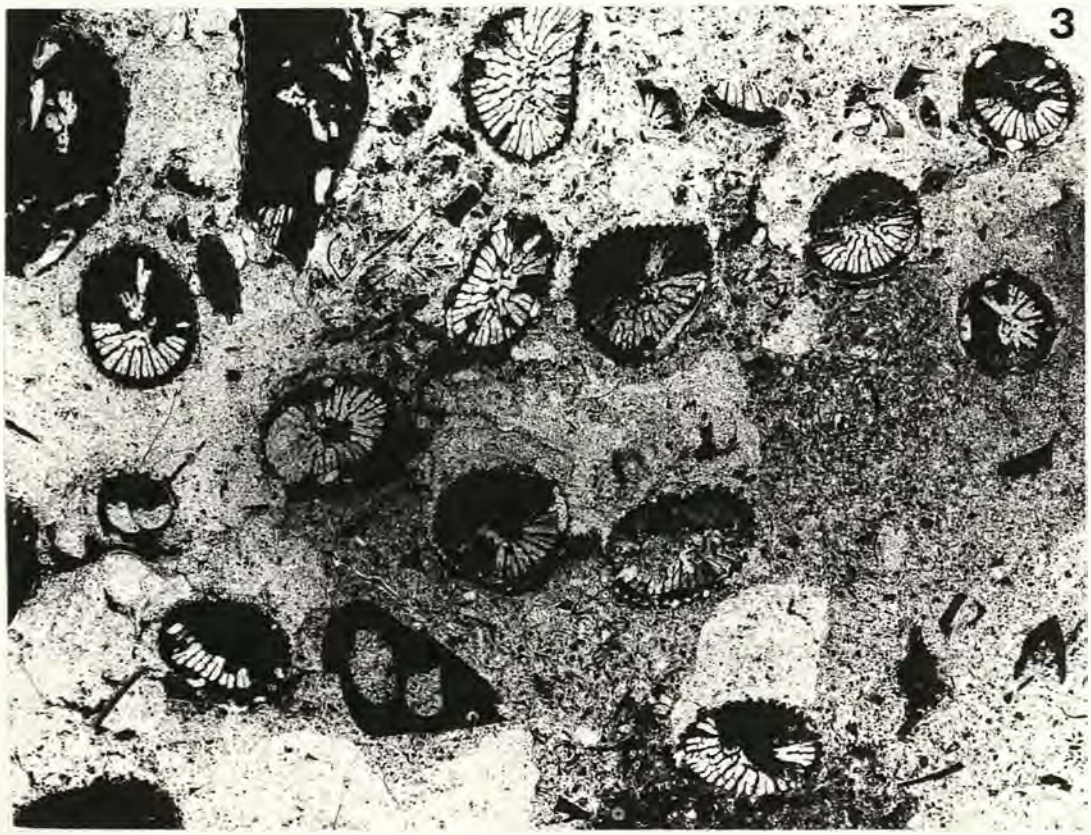


Plate 3.21: *Thamnasteria dendroidea* coral thickets; Haudainville reefs; upper reef complex.

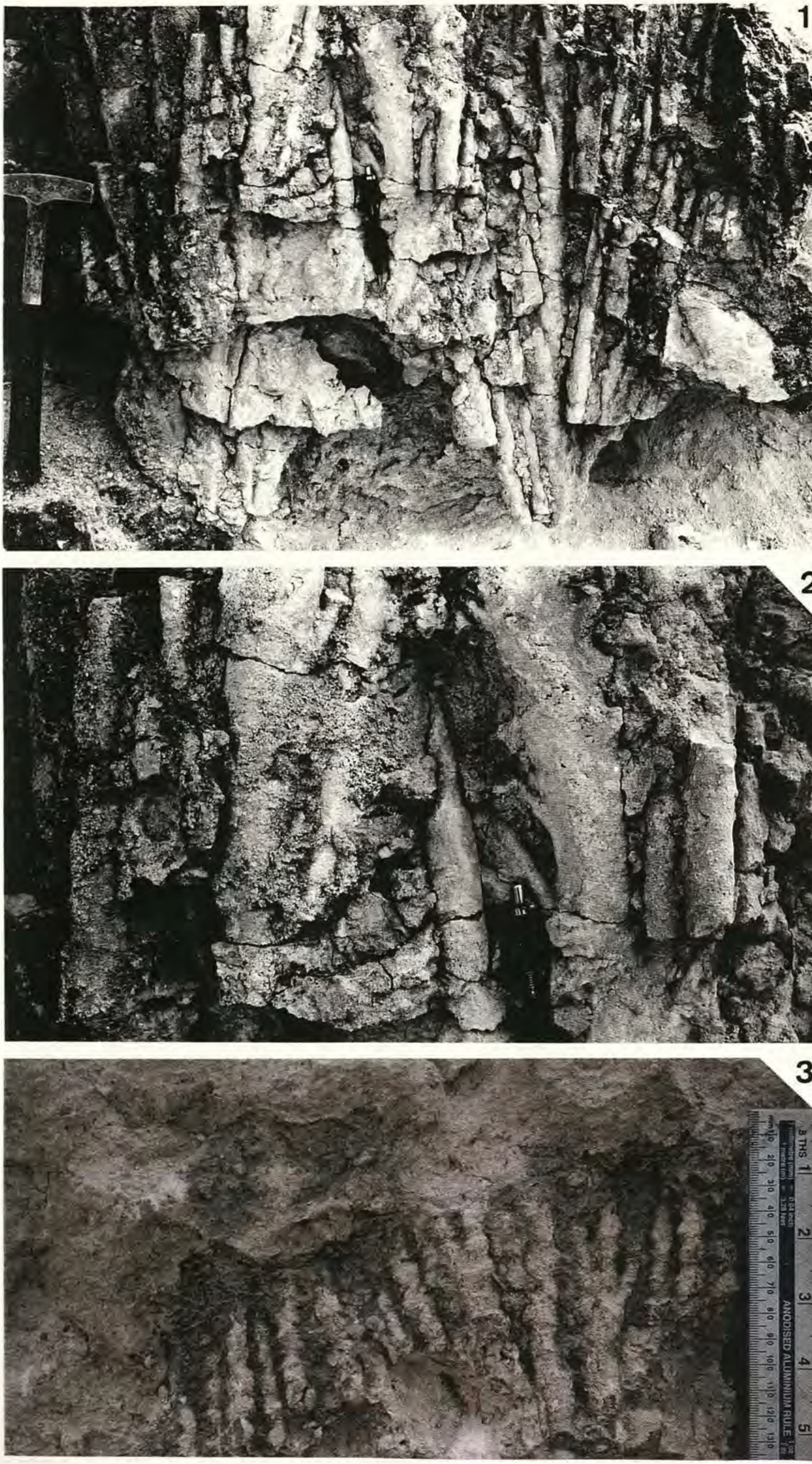
Figure 1: An extensive well developed thicket almost solely constructed by the branching ramose coral *Thamnasteria dendroidea*.

1

Plate 3.22: Details of the *Thamnasteria dendroidea* coral thickets; Haudainville reefs; upper reef complex.

Figures 1-2: Figure 1, details of the *Thamnasteria dendroidea* colonies constructing the thickets in plate 3.21. Note the high branch packing density of the colonies; hammer 32 cm. Figure 2: Details of the coral branches which possess a lateral budding pattern. Part of pen showing about 8 cm.

Figure 3: A peculiar form of ?*Thamnasteria dendroidea* where the individual branches thin and thicken regularly at approximately 1.5 cm intervals (?seasonal). The top of the colony is truncated by storm-deposited debris.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3
8 THS
ANODISED ALUMINIUM RULE

Plate 3.23: Foliaceous "rose" coral colony; Haudainville reefs; upper reef complex.

Figure 1: A "rose" ?*Fungiastraea* colony formed by successive upward growing foliaceous sheets. Pen 15 cm.

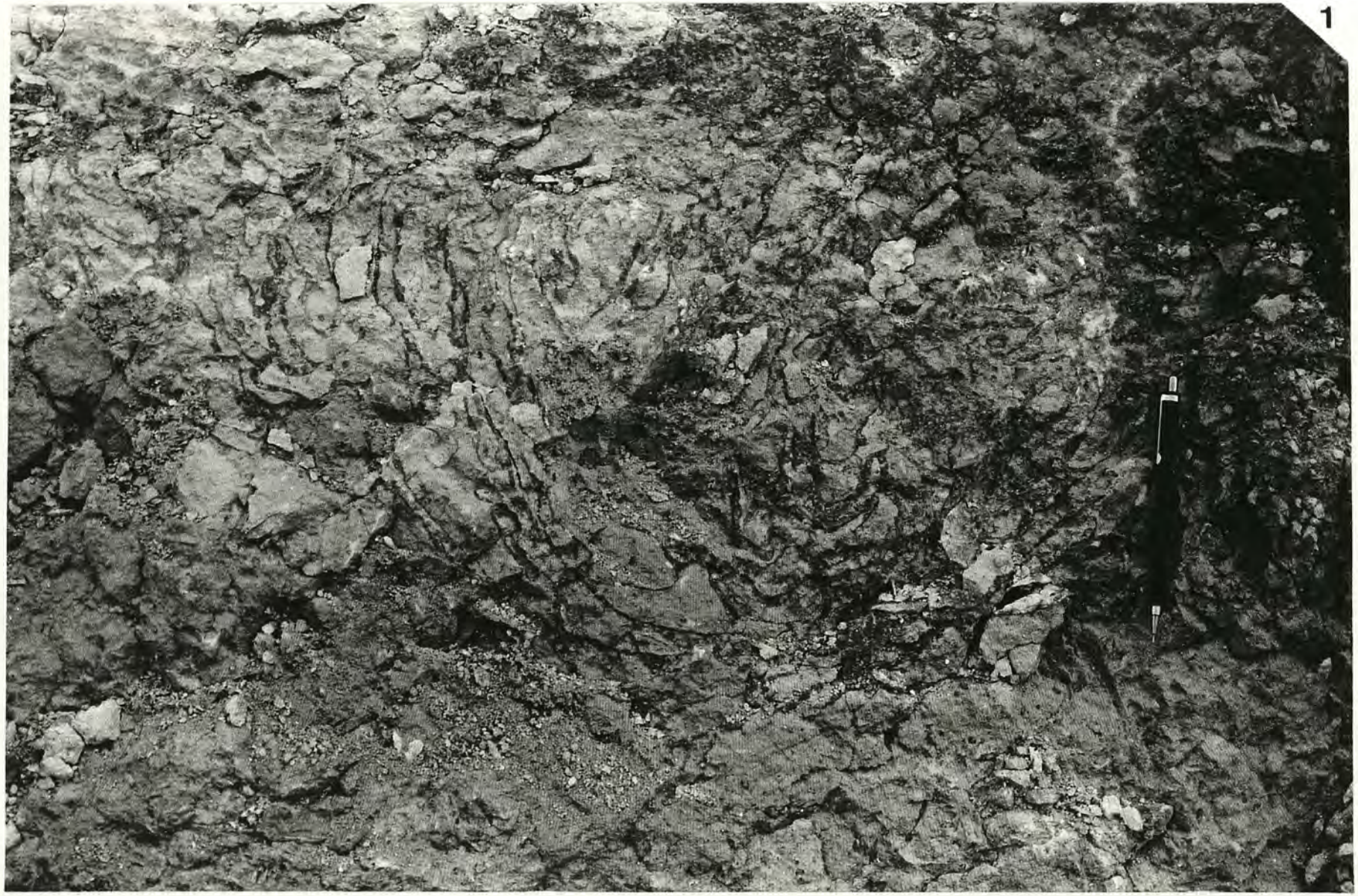
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Plate 3.24: Foliaceous coral colonies; Haudainville reefs; upper reef complex.

Figure 1: Details of the upward growing foliaceous plates of the rose colony in plate 3.23; height of frame 18 cm.

Figures 2-3: Planar *Fungiastraea* foliaceous sheets. Width of frame 70 cm.

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Plate 3.25: Foliaceous coral colonies; Haudainville reefs; upper reef complex.

Figures 1-2: Foliaceous *Meandraraea* colonies. Pen in figure 2: 15 cm.

Figure 3: Very thin foliaceous sheets of ?*Thamnasteria*; hammer 32 cm.

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Plate 3.26: Foliaceous coral colonies; Haudainville reefs; upper reef complex.

Figures 1-2: Figure 1, long thin sheets of an *Actinaraea* colony; hammer 32 cm. Figure 2, details of figure 1, note that there are a number of cavities directly below some of the coral sheets. These are a result of sediment sheltering below the coral sheets, and host a cryptic fauna primarily of serpulids, bryozoans and thecidean brachiopods. Width of frame in figure 2: 22 cm.

Figure 3: Details of a coral plate (?*Fungiastraea*) sprouting very thin vertical sheets. Width of pen 1 cm.

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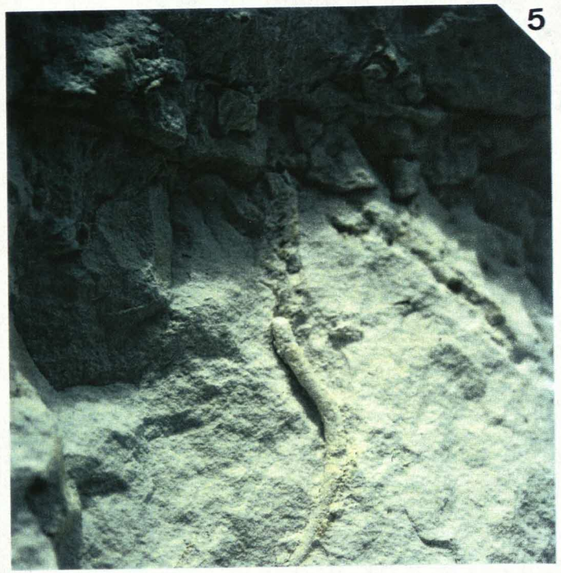
Plate 3.27: General view of the Dompcervin section and the coral channels; Dompcervin; Oolith de St. Mihiel (post upper reef complex).

Figure 1: Photomontage of the section studied in detail. The majority of the section represents a series of stacked channels. Field of view: approximately 30 m.

Figures 2-4: Details of the debris-bearing channels within the sequence. Figure 2, clear erosive base of a debris-channel cutting into a fine grained pelsparite (which itself represents the intra-channel fill at the margins of another channel). Figure 3, mixed composition channel rich in corals, diceratids and terebratulid brachiopods. Note large diceratid to the left of the hammer. Figure 4, coral-rich channel. Hammer in all figures 32 cm.

Figure 5: *Skolithos* burrow truncated by the base of a channel; width of frame 13 cm.



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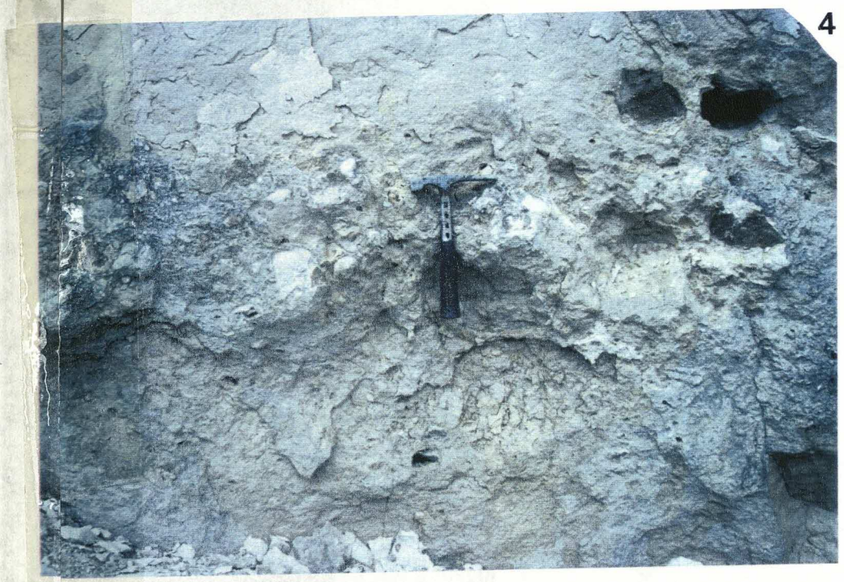

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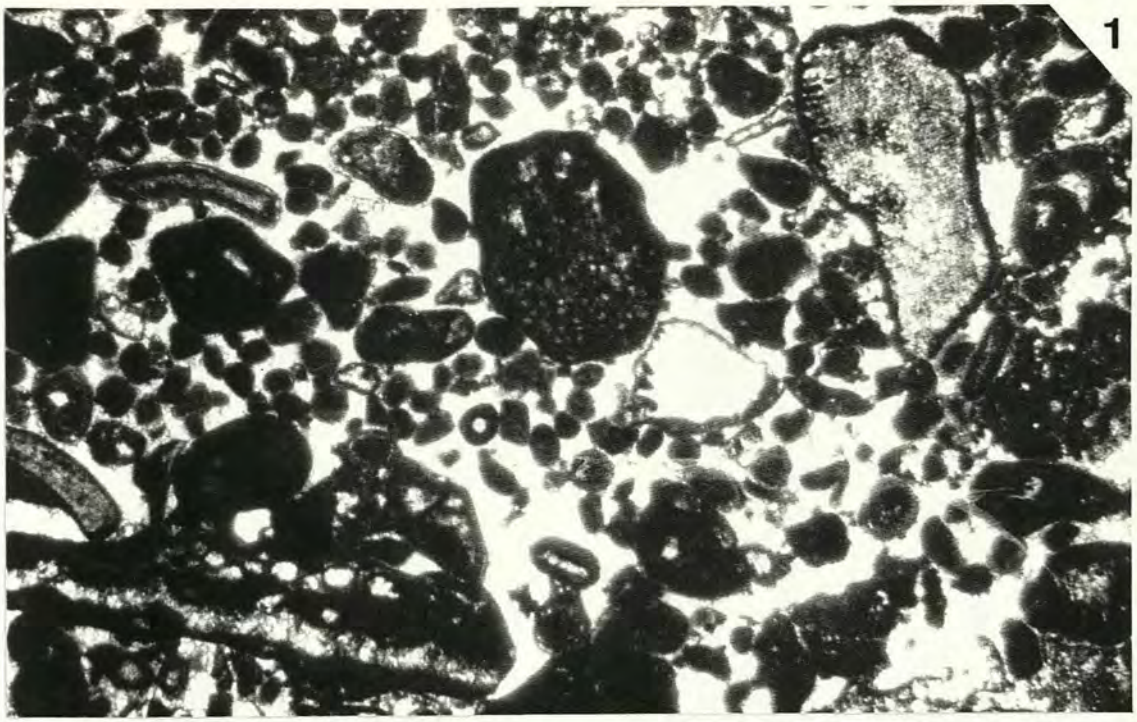
Plate 3.28: Intra-channel sediment microfacies; Dompcervin; Oolith de St. Mihiel (post upper reef complex).

Figures 1-3: Range in microfacies types in the central body of the intra-channel sediments. Figure 1: biointrasparite; figure 2: poorly washed biointrasparite; figure 3: biointramicrite. Note the abundance of peloidal lithoclasts, biogenic material, spongiostromate coatings and highly micritized grains (bioclasts and ooids). Height of all frames: approximately 2.6 mm.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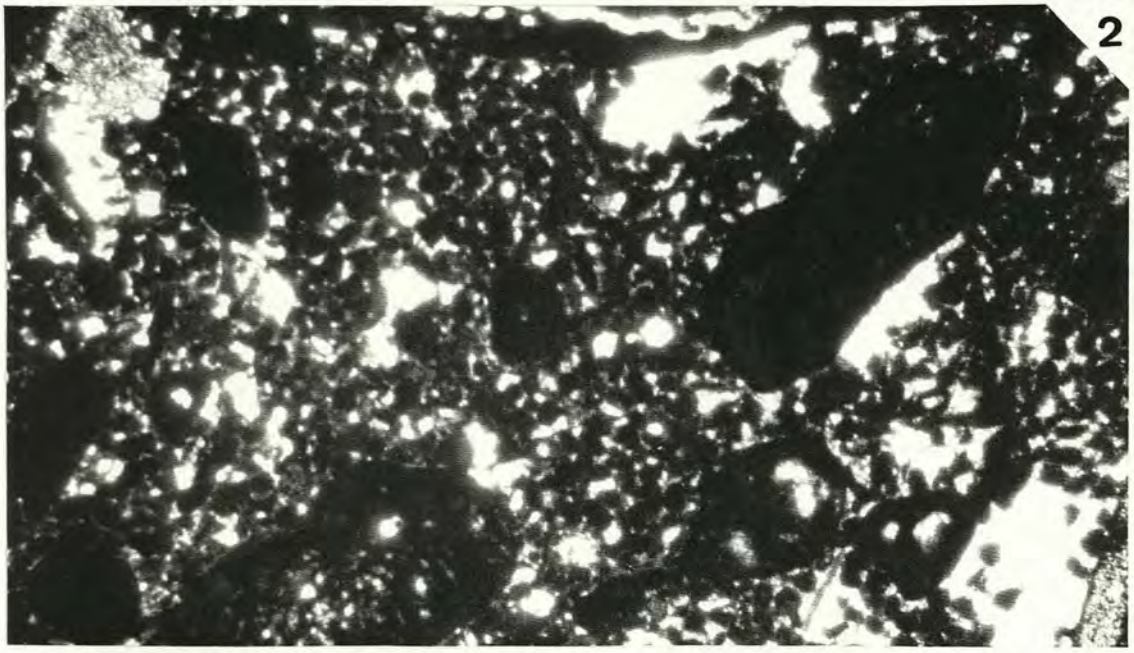
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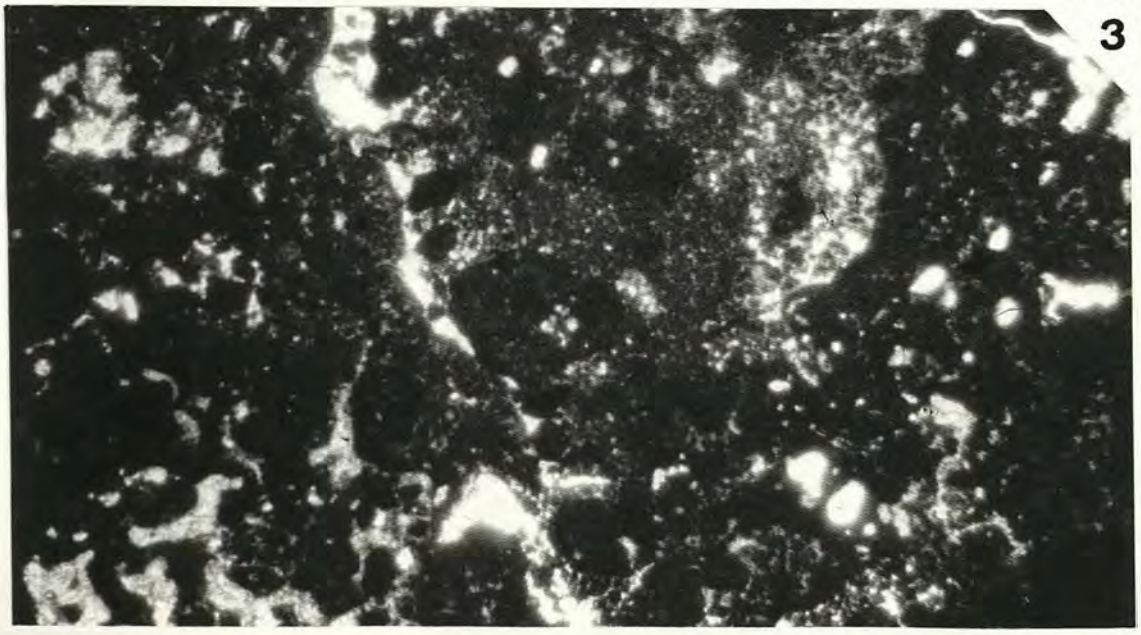
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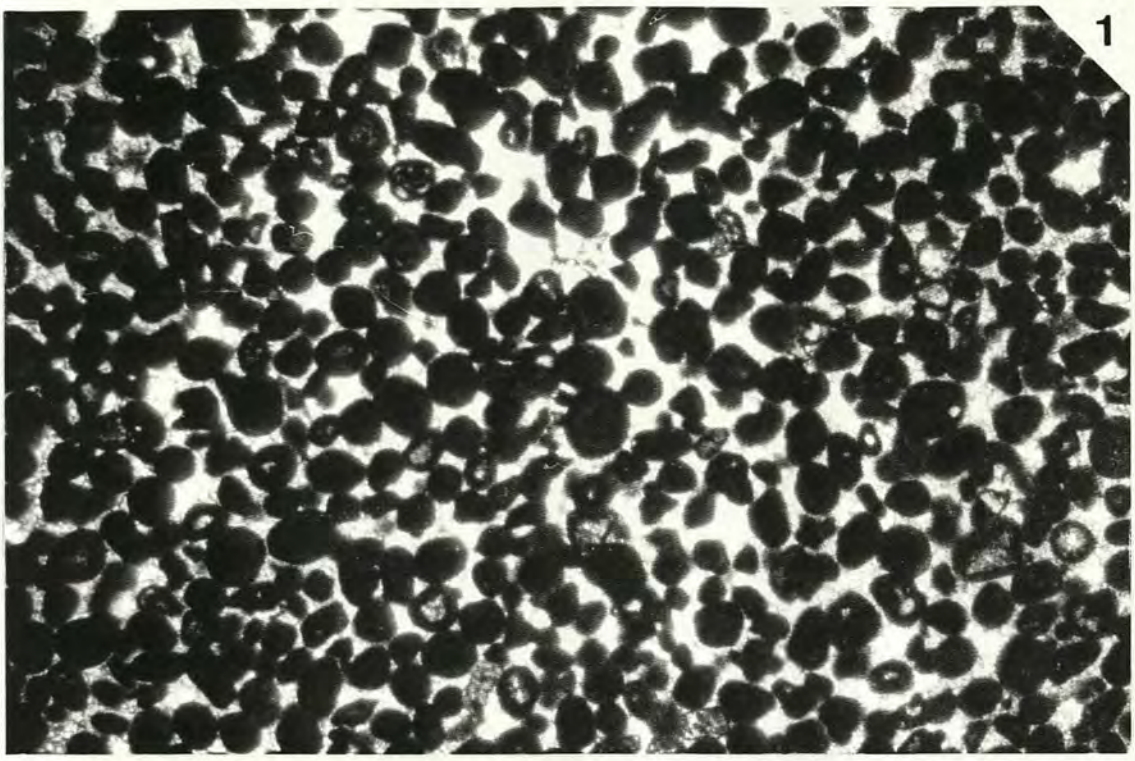
Plate 3.29: Intra-channel sediment microfacies and problematic encrusters; Dompcervin; Oolith de St. Mihiel (post upper reef complex).

Figure 1: Intra-channel sediment of the channel margins. Fine grained, well sorted pelmicite. Note the abundance of forams. Height of frame: 3 mm.

Figure 2: *Lithocodium* crust. Height of frame: 2.5 mm.

Figure 3: Problematic chambered encruster. Height of frame: 2.4 mm.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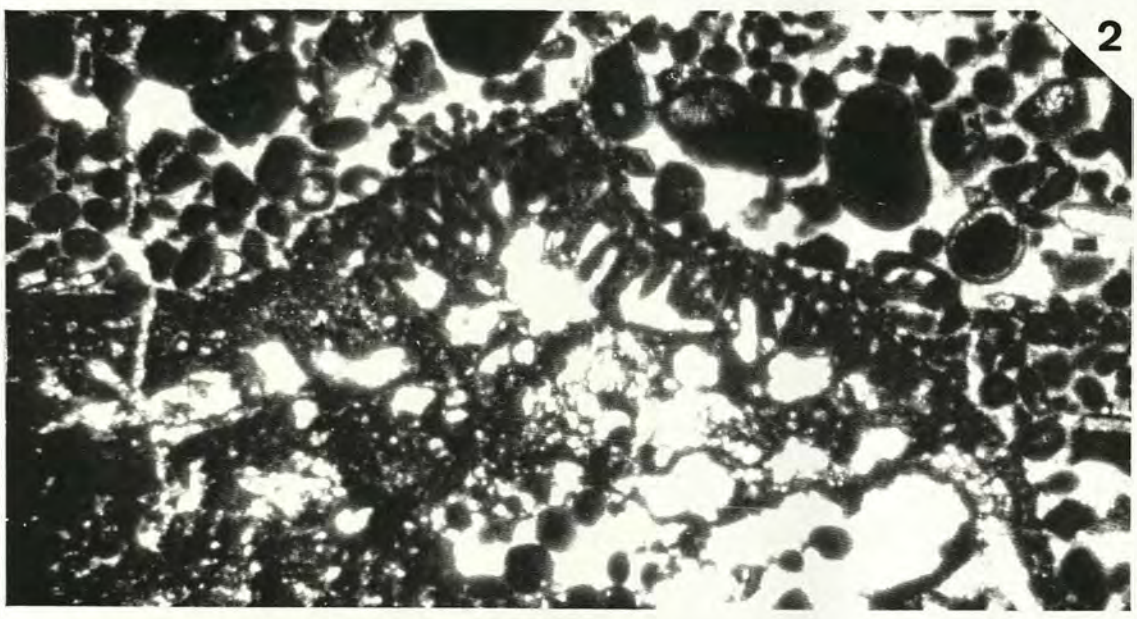
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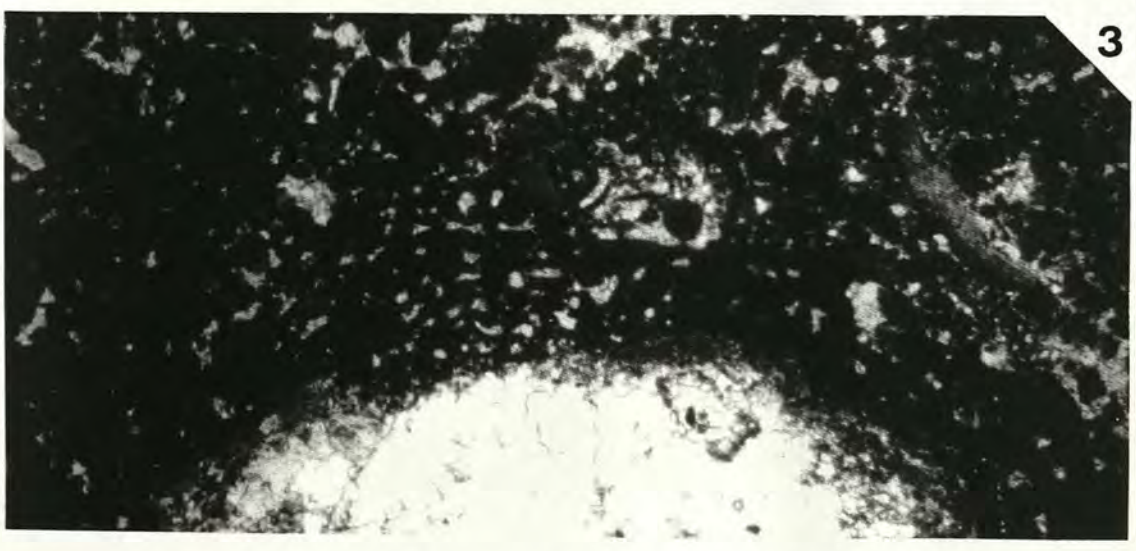
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Plate 3.30: "Coral ball" and *Meandrophyllia*; Dompcervin; Oolith de St. Mihiel (overlying the upper reef complex).

Figures 1-3: Figures 1-2, general views of the coral ball; width of frame 80 cm in figure 1; figure 2, pen 15 cm., Figure 3, oblique section through the coral ball showing the outer coral skin and the internal coarse grained bioclastic packstones; hammer 32 cm.

Figure 4: Surface details of the coral ball which is covered by the coral ?*Diplocoenia*. Width of frame 4.5 cm

Figure 5: Thin section through a *Meandrophyllia* colony, examples of which are abundant within the coral-bearing channels. Negative print from thin section; width of frame 4.4 cm.

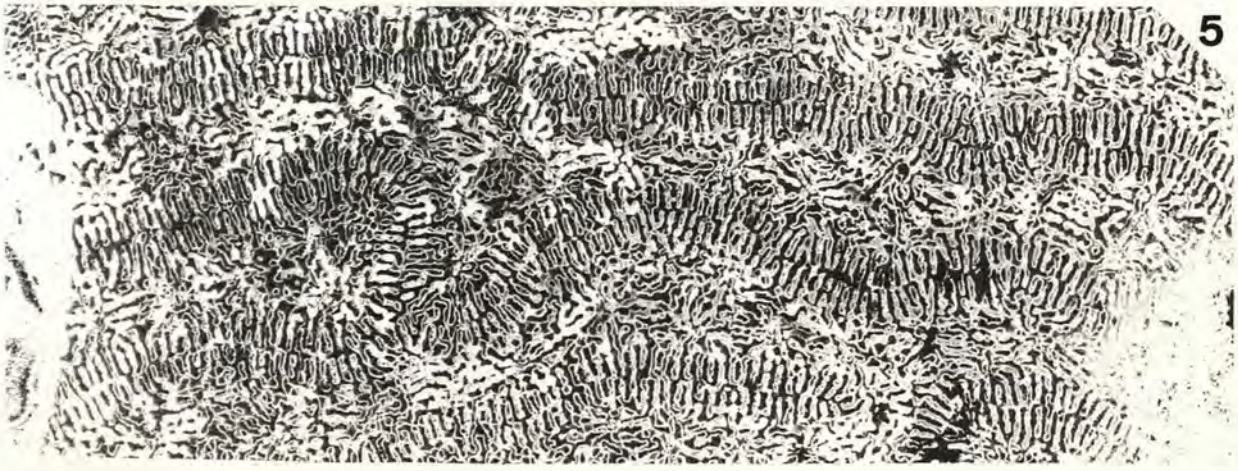

Plate 4.1: Reef and its relationship with the surrounding facies; quarry 3; l'Épine; Novion-Porcien.

Figure 1: Form and geometry of the main reef in quarry three. Markus Bertling for scale.

Figure 2: Facies relationship between the reef, peloidal sandwave and reef rubble facies. Note that at the top of the reef the relationship between the reef and the sandwave is an onlapping one, but at the lateral margins of the reef it is gradational. Markus Bertling for scale.

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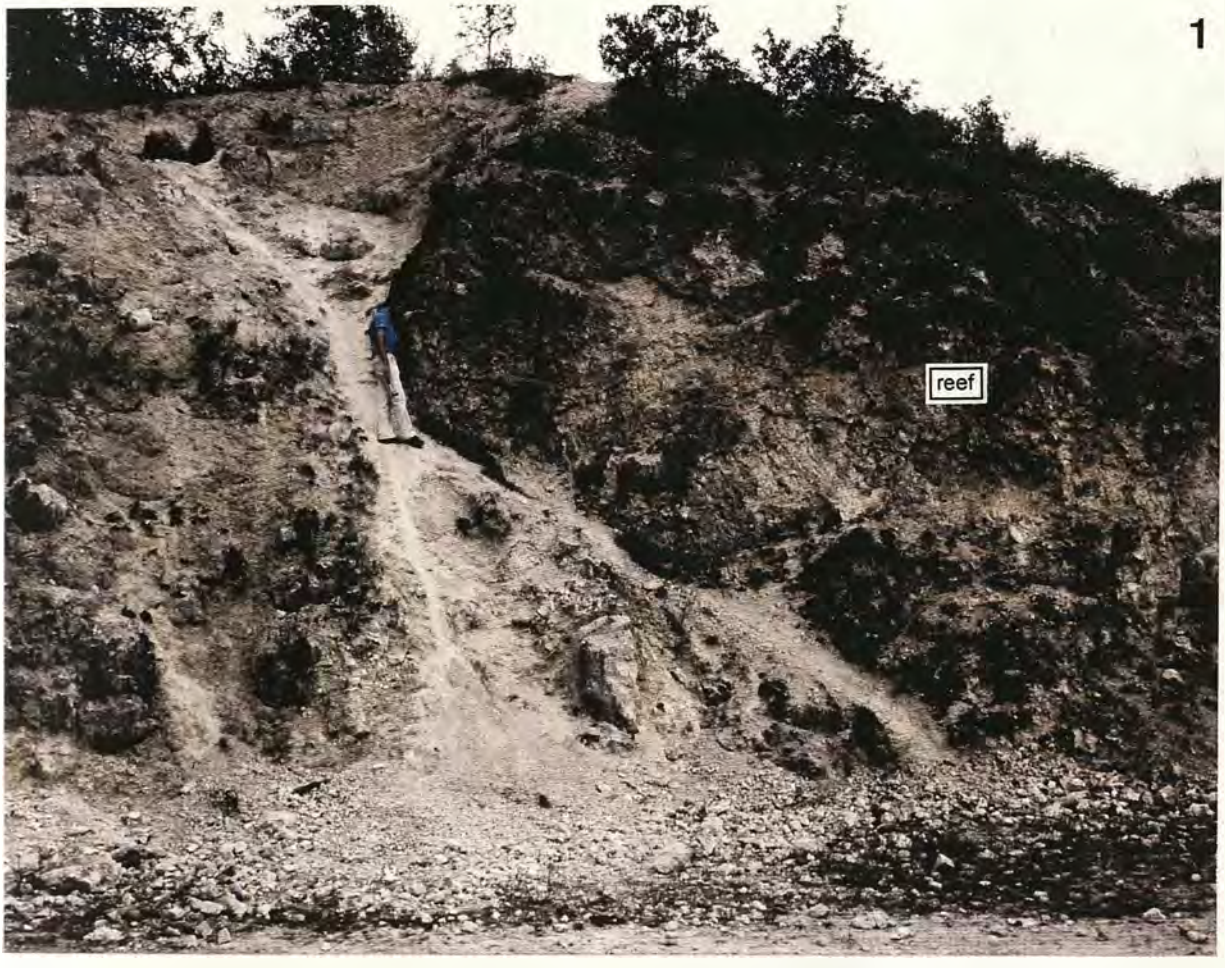
reef

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reef rubble facies
onlapping relationship
peloidal grainstone sandwave
transitional facies
gradational facies change

Plate 4.2: Facies associated with reefal units; quarry 2 and 3; l'Épine; Novion-Porcien.

Figure 1: Foreset geometry of the peloidal sandwave. Height of frame in the centre of the figure approximately 10 m.

Figure 2: Reef rubble facies built up by successive sheets and channels of reef debris. The base of successive sheet and channels are often, though not always, clearly erosive. Hammer 32 cm.

Figure 3: Details of the reef rubble facies occurring within a channel in quarry 2 showing 4 nerineid gastropods amongst the debris. Height of frame 1 m.

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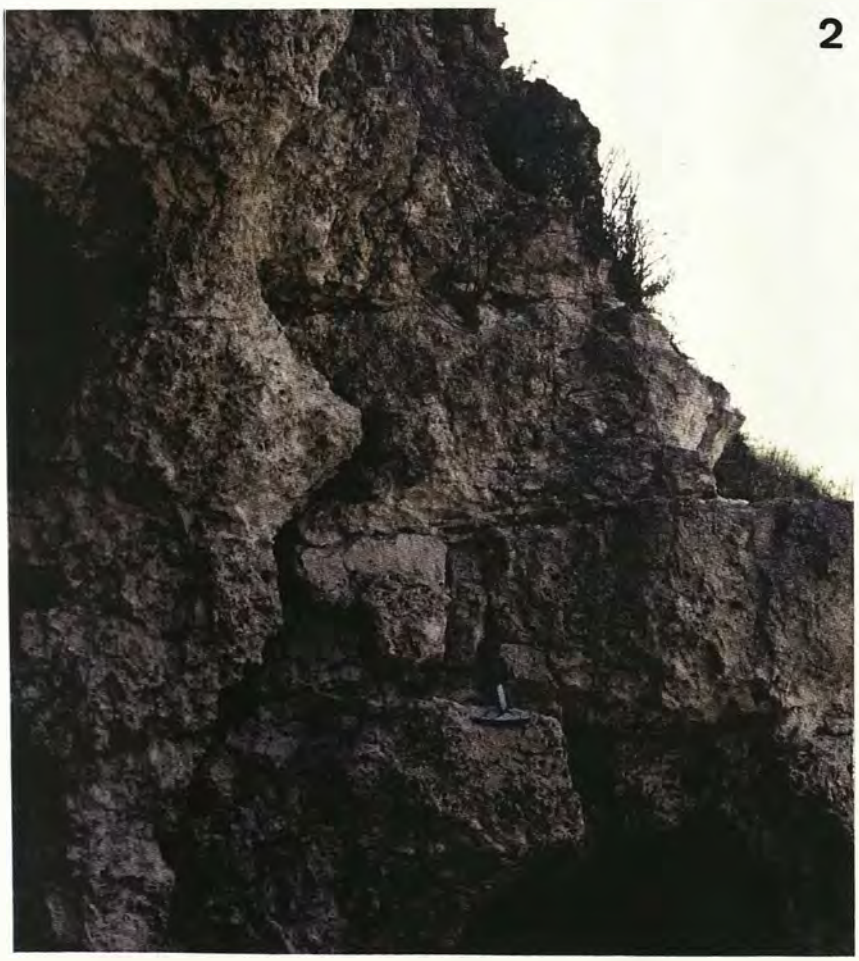

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Plate 4.3: *Dendrohelia* dominated reef rubble facies; quarry 3; l'Épine; Novion-Porcien.

Figures 1-2: Details of the fabric of the reef rubble facies occurring as sheets. These sheets tend to be packed with the broken branches of *Dendrohelia coalescens*. The white material in-between the coral debris in figure 2 is a hard dense white microbialite. Figure 1: height of frame 40 cm; figure 2: 50 cm.

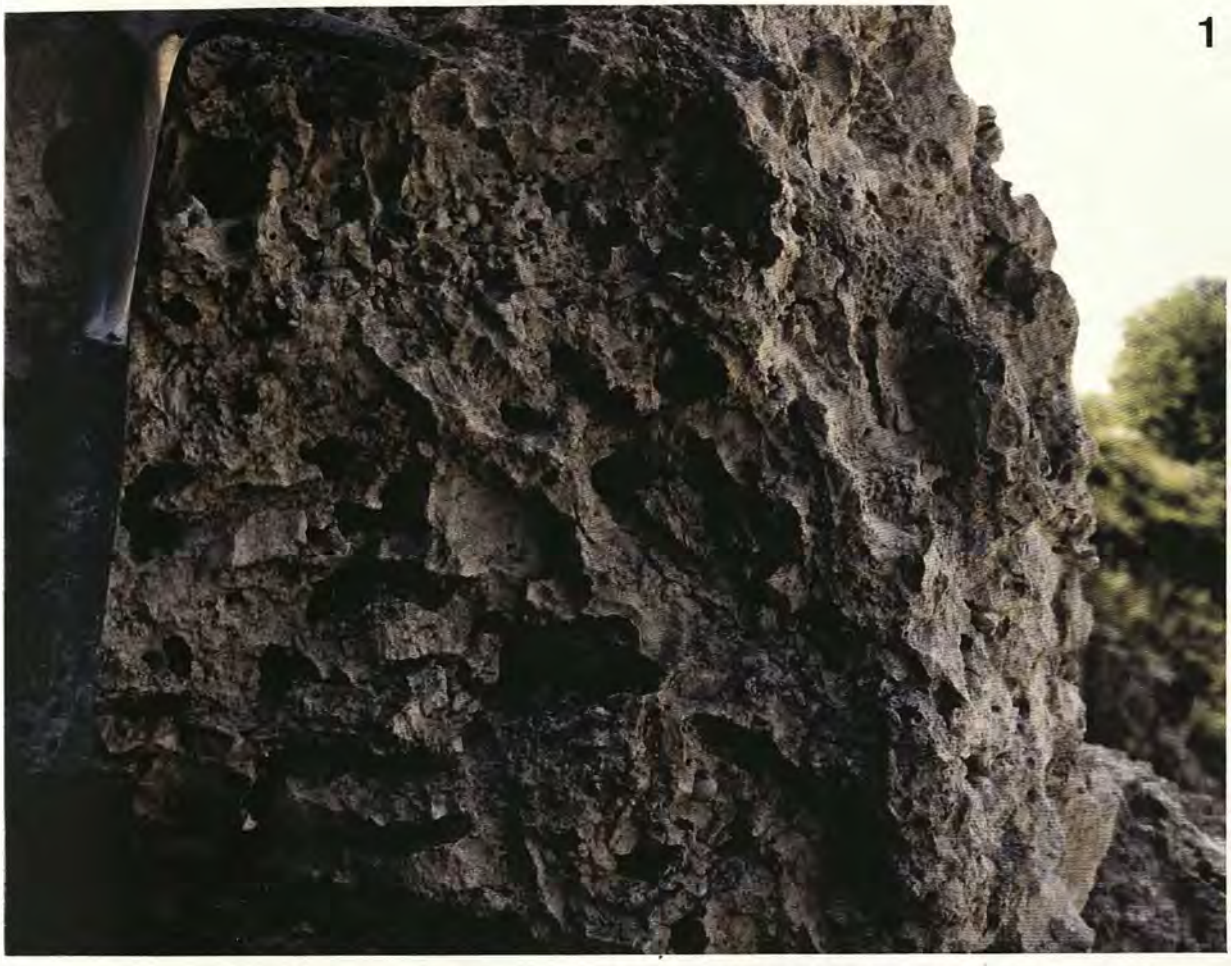

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Plate 4.4: Reef facies and fabric; quarry 3; l'Épine; Novion-Porcien.

Figures 1-2: Reef fabric dominated by branching ramose forms. These two figures show the main framebuilder *Thamnasteria dendroidea* (type A). Figure 1: Note the very thin branches which are very loosely packed and have a sinuous form; hammer 32 cm. Figure 2: Another very loose colony of *T. dendroidea* (type A). In this figure it appears from a casual observation that this is a fragmented colony. However closer examination of the colony reveals that it is actually in situ and is simply a very loose form. Height of frame 70 cm.

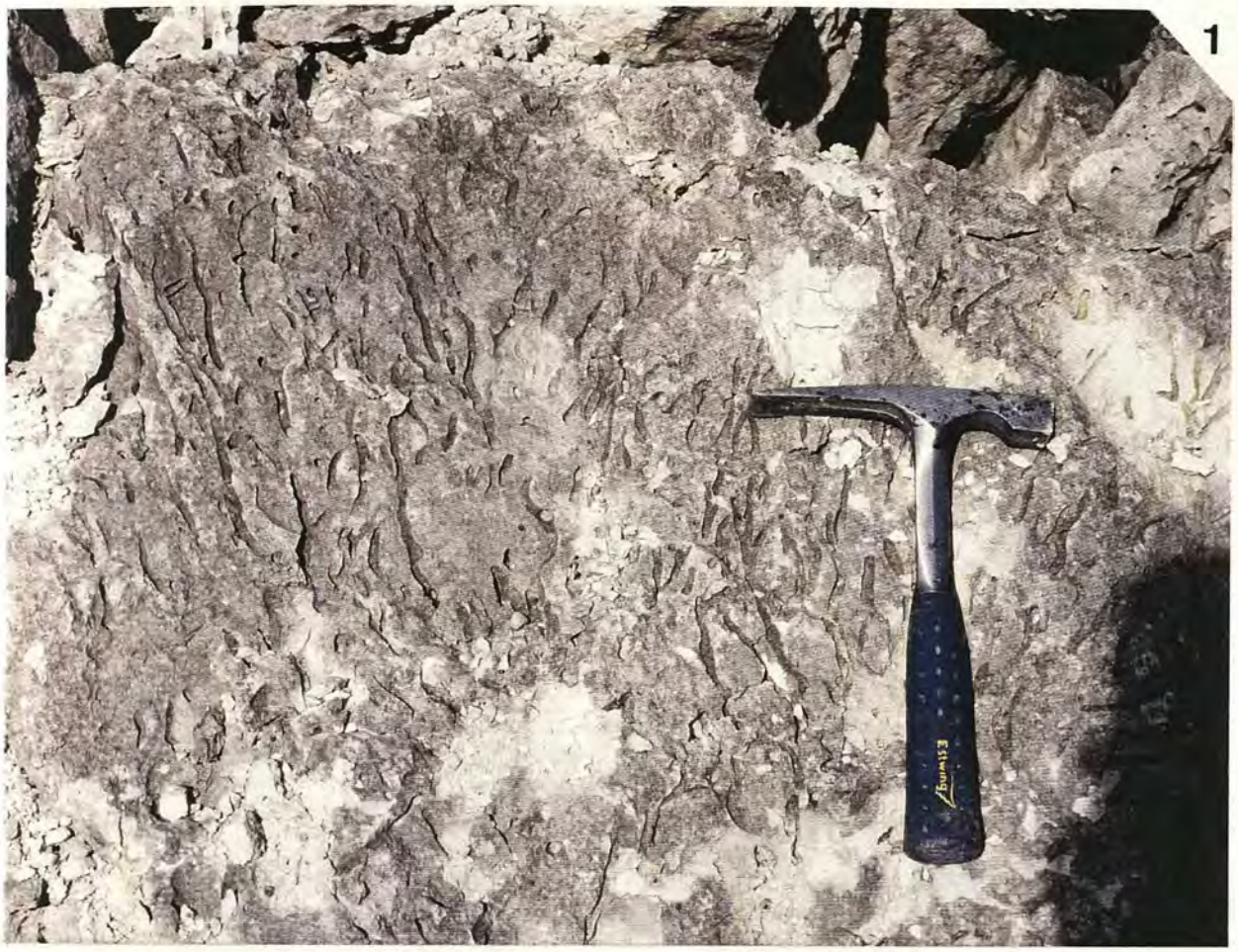

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Plate 4.5: "Pillow" microbialites; quarry 3; l'Épine; Novion-Porcien.

Figures 1-3: "Pillow" form microbial masses which have developed in the primary cavities of the reef framework. Figure 1: frame 2.5 m across; figure 2: hammer head 19 cm across. Figure 3: Details of the outer surface of the pillow which has a clotted fabric. Despite a concerted search for encrusters on these microbial structures only a very small number of thecidean brachiopods, serpulids and encrusting bivalves were found. Hammer head 19 cm across.


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Plate 4.6: "Pseudostalactite" microbialites; quarry 3; l'Épine; Novion-Porcien.

Figures 1-2: Figure 1: A cluster of pseudostalactite microbialites hanging from a palaeocave ceiling; height of frame 50 cm. Figure 2 details of one of the pseudostalactites. The material below the pseudostalactite is chalky sediment rich in foraminifera; hammer head 19 cm.

Figure 3: Details of the surface of a microbial pseudostalactite covered by numerous accreted microbial pendants. Note the boring bivalve to the left of the sample number. Major divisions on the scale are in centimetres.

As with the microbial pillows these structures appear to lack an encrusting cryptic fauna (even when searched for in slabbed sections).


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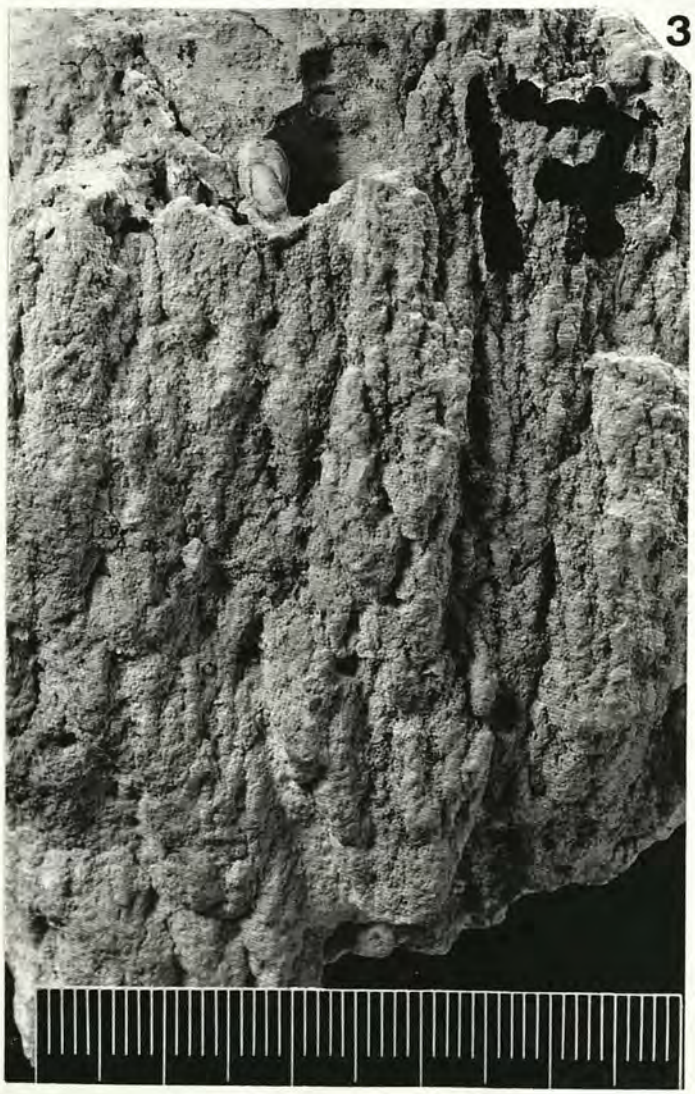
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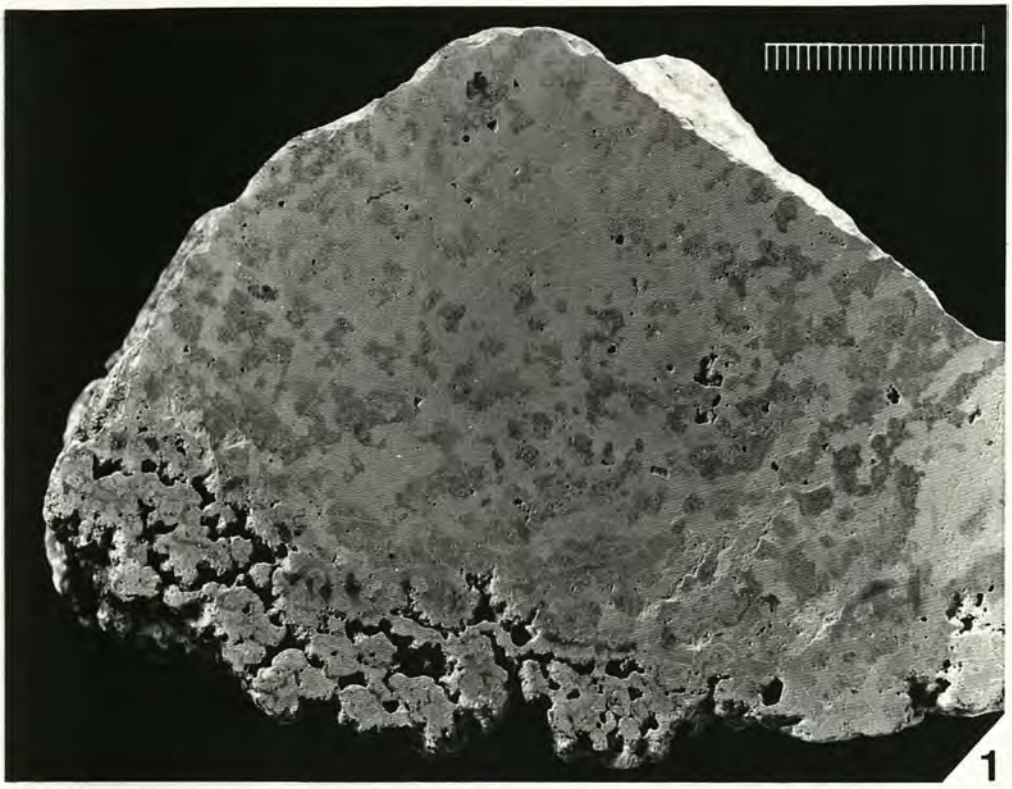
Plate 4.7: Polished slabs through microbial pseudostalactites; quarry 3; l'Épine; Novion-Porcien.

Figures 1-2: Transverse sections through a microbial pseudostalactite. Figure 1: Dark clots in the main body of the pseudostalactite are primary pores that have been infilled by fine detrital material, peloids and sparite. Scale in mm. Figure 2: Details of the pores inbetween individual microbial pendants around the outer edges of the pseudostalactite. Scale in mm.

Figure 3: Longitudinal section through a microbial pseudostalactite. Note that in longitudinal section the clots are rather elongate. Major divisions on scale in centimetres.



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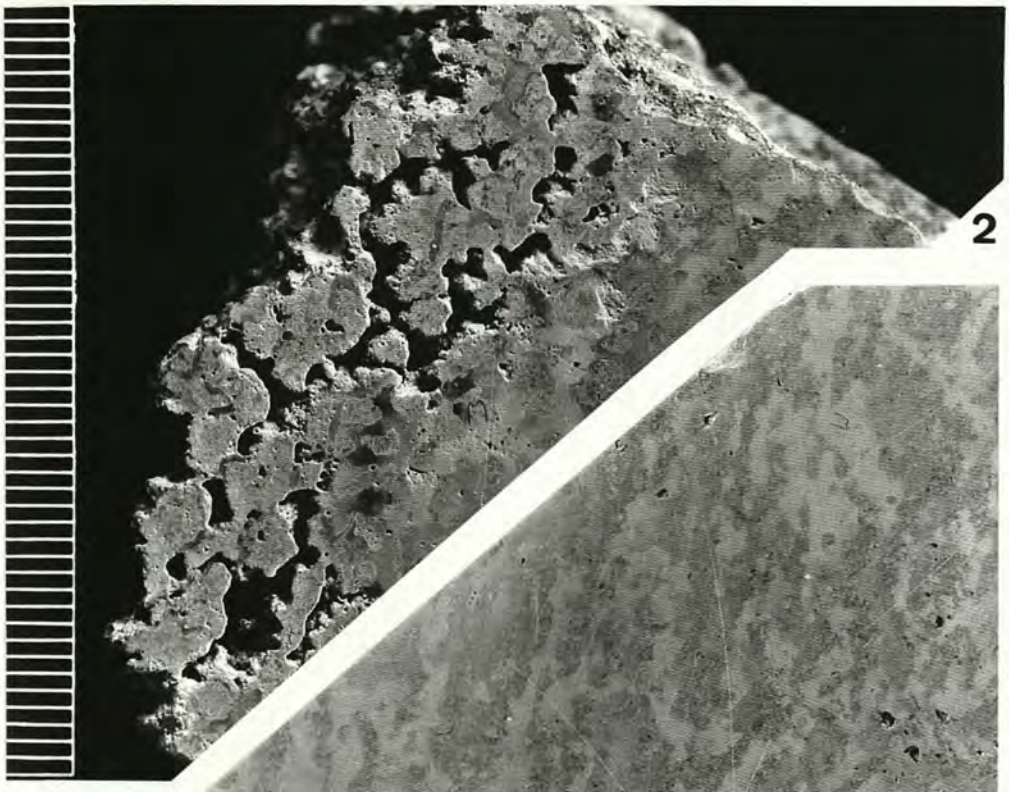

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Plate 4.8: Coral fauna; reef facies; quarry 2-3; l'Épine; Novion-Porcien.

Figures 1-2: Figure 1: Branch of *Thamnasteria dendroidea* (type A). Figure 2: Calicular details of figure 1.

Figures 3-4: Figure 3: Branch of *Allocoenia* sp. Figure 4: Calicular details of figure 3.

All these figures are of latex peels from natural casts. All scales in mm.

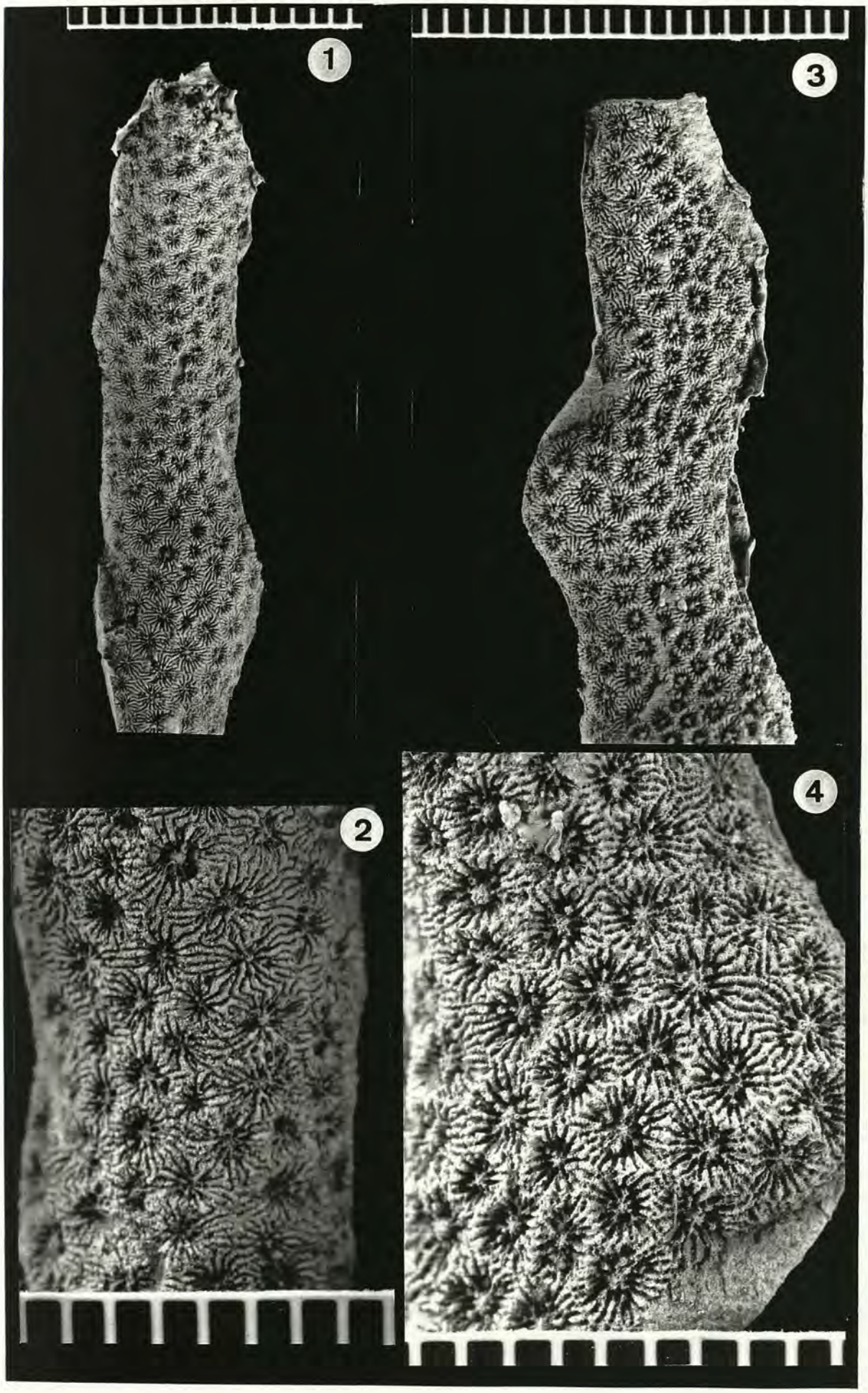
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Plate 4.9: Coral fauna; reef facies; quarry 2-3; l'Épine; Novion-Porcien.

Figures 1-2: Figure 1: *Dendrohelia coalescens*; figure 2, calicular details of figure 1.

Figures 3-4: Figure 3: *Diplocoenia* sp.; figure 4, calicular details details of figure 3.

Figure 5: ?*Thamnasteria* sp. Form with large calices.

All these figures are of latex peels from natural casts. All scales in mm.

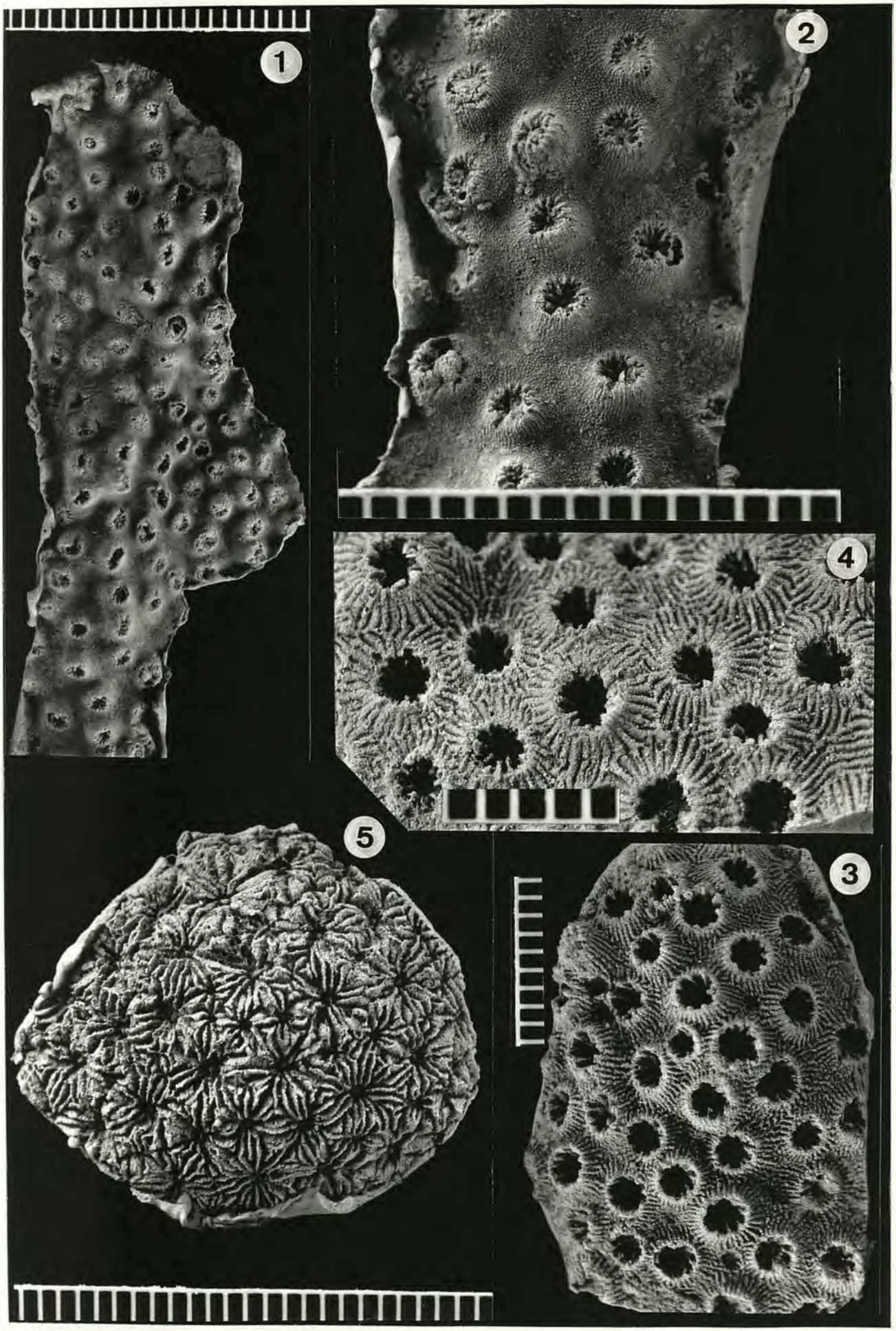
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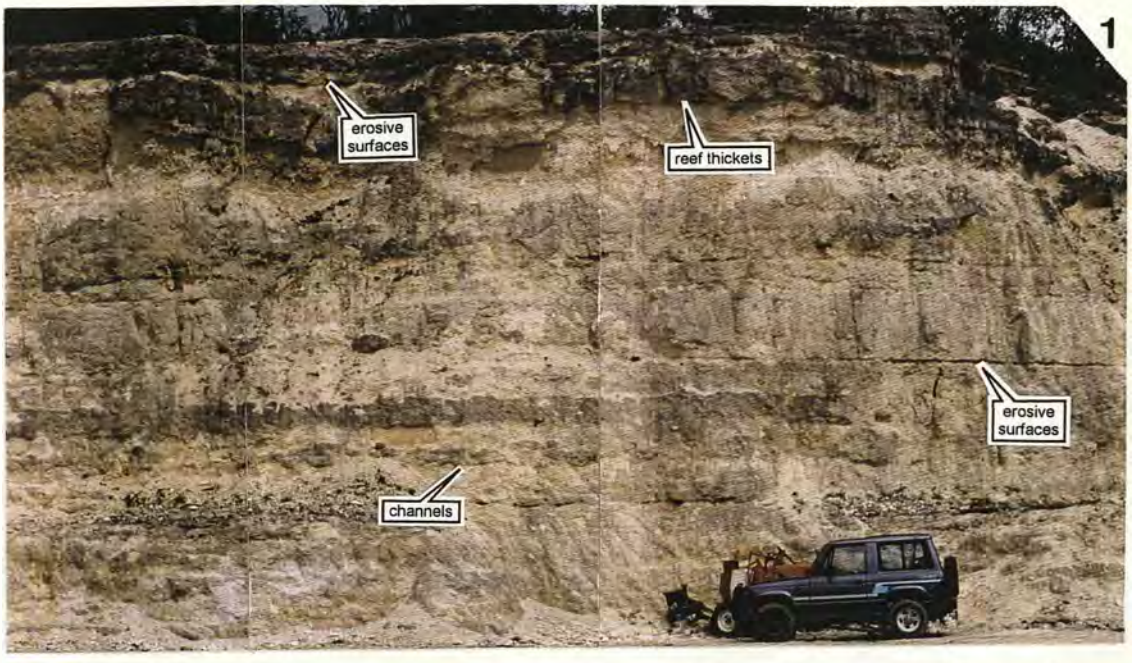
Plate 4.10: Details of the section and reef fabric at Bellême s/s Apainei.

Figure 1: General view of the Bellême section. The coral thickets are located in the top 2 metres of the section. The rest of the section below the coral thickets is built up from interbedded sheets and channels of oolites, oncolites and biogenic debris. The prominent surfaces are erosive. One of these erosive surfaces cuts through the middle of the reef thickets. Jeep 1.45 m.

Figures 2-3: Details of the upper part of the section. Figure 2: height of frame 4m; figure 3: height of frame 6m.

Figure 4: Details of the reef fabric which is dominated by colonies of the thinly branched *Thamnasteria dendroidea* (type A).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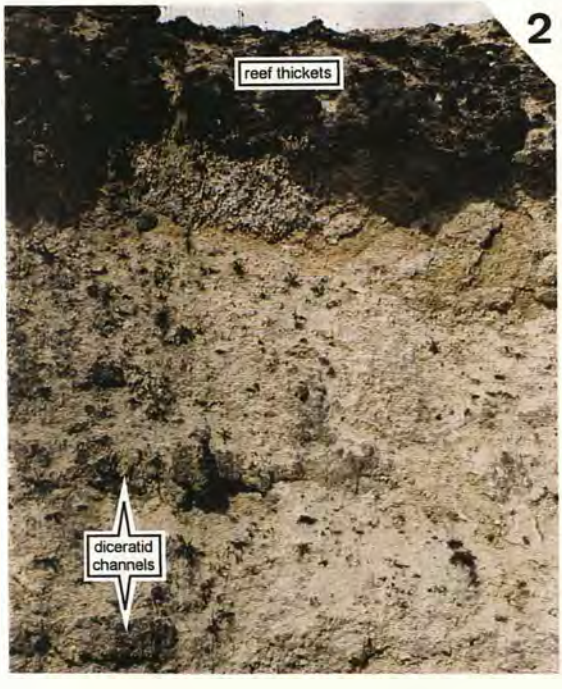
erosive surfaces
reef thickets
erosive surfaces
channels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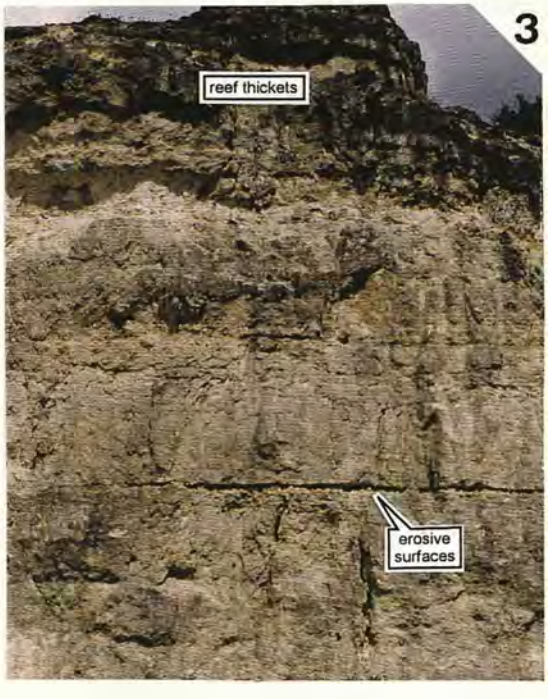
reef thickets
diceratid channels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reef thickets
erosive surfaces


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Plate 4.11: Diceratid bank; Bellême s/s Apainei.

Figures 1-3: Details of a major diceratid bank. These have a monospecific composition of *Eodiceras perversum* (pers. comm. P. W. Skelton, 1995). Figure 1: Ruler 7 inches; figure 2, scale in inches; figure 3: height of frame: 4 inches. The majority of the diceratids in this deposit are in growth position.


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ANODISED ALUMINIUM RULE
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Plate 4.12: Associated fauna; Bellême s/s Apainei.

Figures 1-3: Figures showing the high intensity of bivalve bioerosion. Note the calicular casts left on the outer surface of the boring moulds. Figure 1: width of frame approximately 15 cm; figure 2: width of frame approximately 7 cm; figure 3: width of frame approximately 5 cm.

Figure 4: Photomicrograph through a longitudinal section of red algae. Height of frame 4 cm.

Figure 5: Transverse sections through a gastropod-rich oncolitic grainstone. Height of frame approximately 8 cm.


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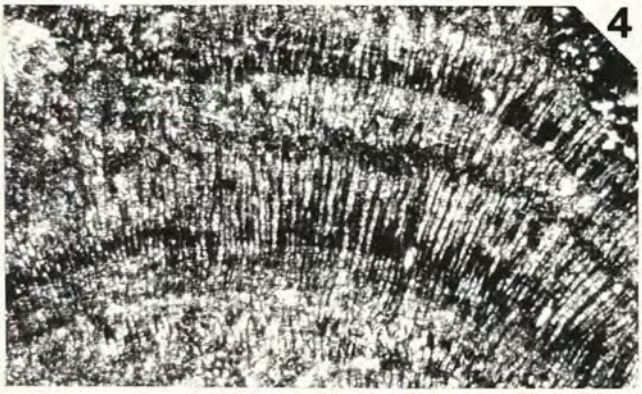
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Plate 4.13: Coral fauna; Bellême s/s Apainei.

Figures 1-2: Natural cast of *Dendrohelia coalescens.* Note the thickness of the branches which can be over 1.5 inches thick. Figure 2: Details of the calicular distribution over the branch. Note in both figures the occasional cast of boring bivalves.

Figure 3: Domal stylinid occurring in a rubble bed. Height of frame 50 cm.

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8 THS
DO IT ALL
ANODISED ALUMINIUM RULE
1 millimetre (mm) = 0.04 inch
1 metre (m) = 3.28 feet
1 oz = 28.35 g
1 lb = 0.45 kg

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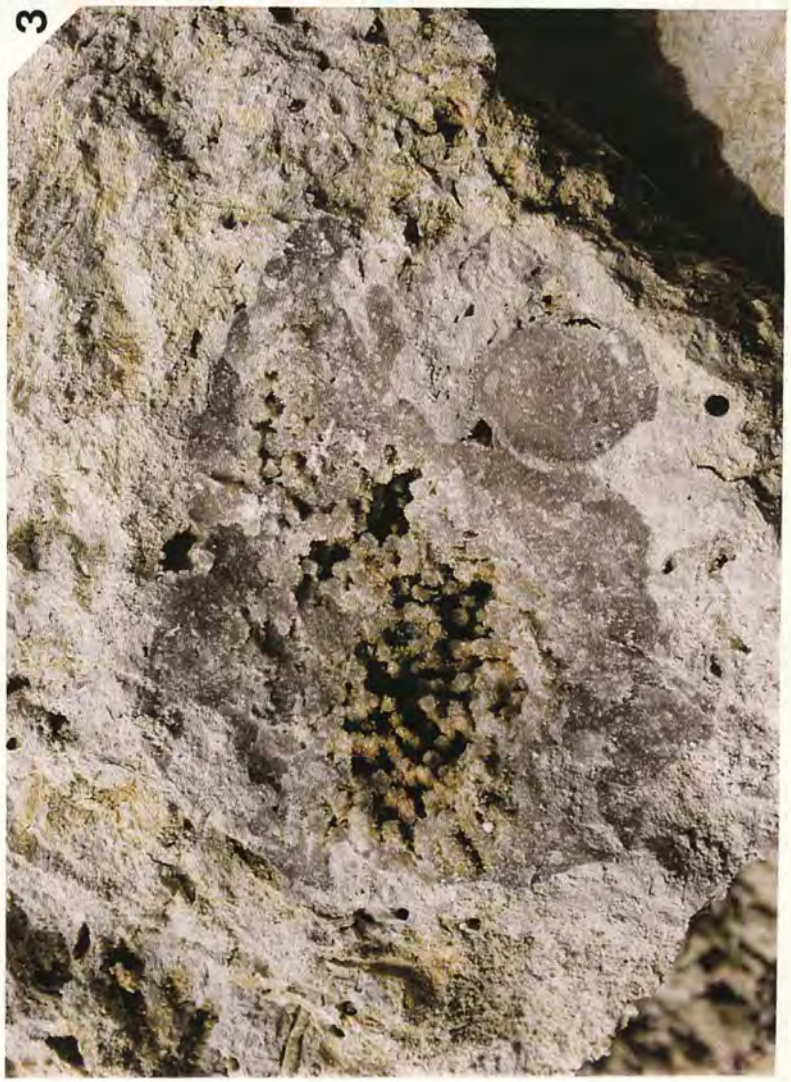

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Plate 5.1: General views of the Liesberg section and the Liesberg biostrome

Figure 1: Panoramic view of the Liesberg section showing the shallowing upward succession from the relatively deep water Terraine à Chailles Member through to the shallow water St. Ursanne Formation. The thickness of the Liesberg Member is approximately 22 m.

Figure 2: Transition from the Terraine à Chailles Member to the Liesberg Member which is marked by a sudden and abundant appearance of corals. Boundary indicated by the arrow. The diagonal height of the section is approximately 25 m.

Figure 3: Details of the Liesberg Member reefal facies. Note the bedded (biostromal) nature of the unit and the marly intercalations. Height of frame approximately 10 m.


1
St Ursanne Formation
Terraine à Chailles Member
Liesberg Member


2
Liesberg Member
Terraine á Chailles Member


3

Plate 5.2: Details of the reefal fabric of the Liesberg Member

Figure 1: Reefal fabric composed of relatively thin coral plates (approximately 1 cm thick); coral skeletal biovolume comparatively low (<15%). Pen 14 cm.

Figure 2: Reefal fabric composed of coral plates 2-3 cm thick; coral skeletal biovolume high (>50%). This type of reef fabric constructs most of the biostrome. Hammer 32 cm.

Figure 3: Reefal fabric composed of irregular crinkly coral plates. Pen 14 cm.

All three fabrics are dominated by microsolenid corals.

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Plate 5.3: The associated fauna of the Liesberg biostrome

Figure 1: The top surface of a *Dimorpharaea* microsolenid plate. The central knob is an encrusting calcareous sponge. Also present on this coral plate are thecidean brachiopods and various serpulids.

Figure 2: Top view of two encrusting calcareous sponges: on the left *Enaulofungia* and on the right cf. *Leuconia*.

Figure 3: Side view of the two encrusting calcareous sponges in figure 2.


cm 1 2 3


cm 1 2 3 4 5 6

Plate 5.4: The associated fauna of the Liesberg biostrome

Figure 1: Top surface of a microsolenid plate encrusted by various oyster type bivalves. The white colour of the encrusters is a consequence of their silicification.

Figure 2: Transverse sections through three *Millericrinus* crinoid stems. Pen 14 cm.

Figure 3: Exposed bedding surface revealing a number of crinoid stems and echinoid spines. Pen 14 cm.

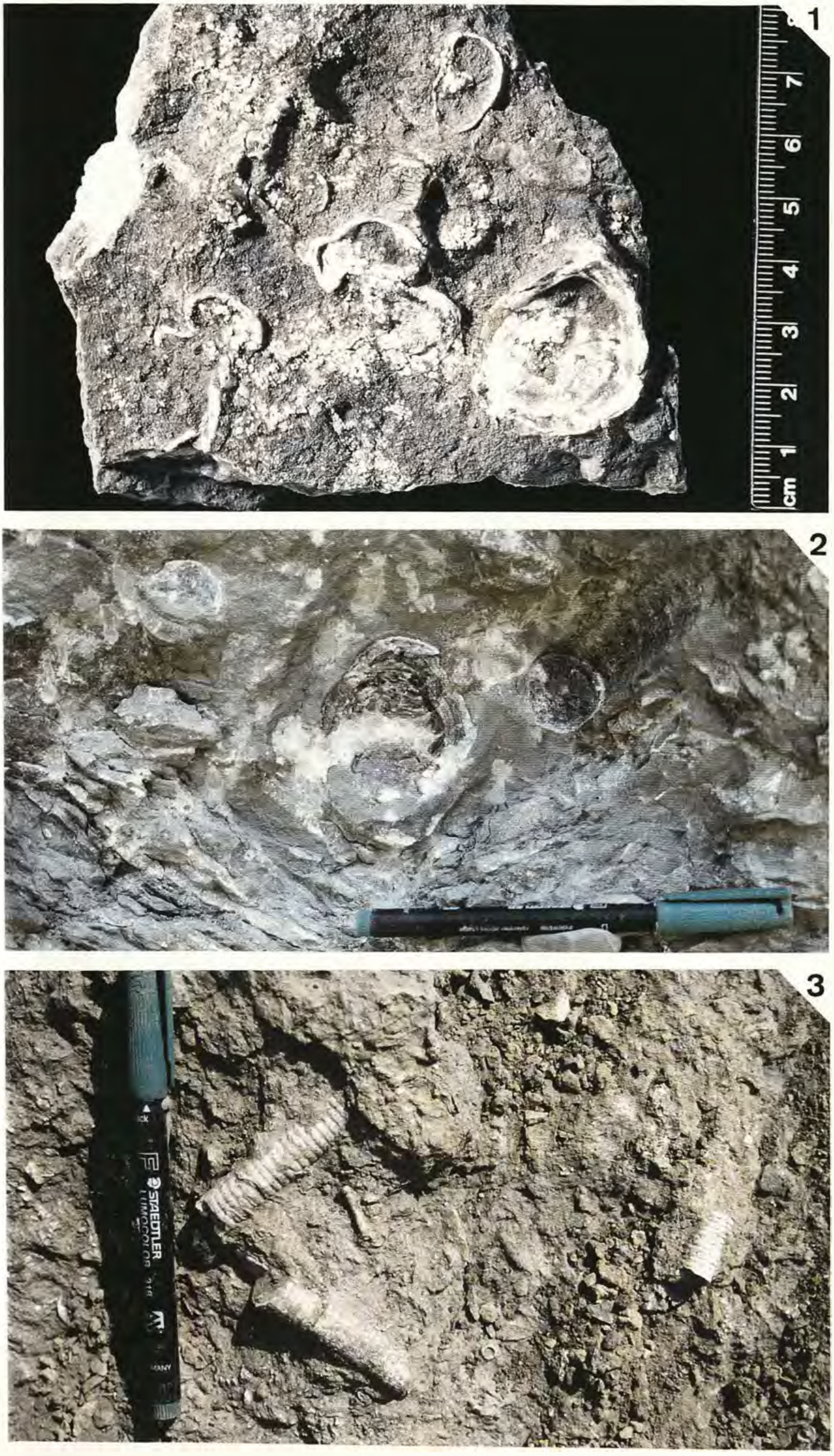
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Plate 5.5: Details of the microsolenid coral framebuilders; Liesberg Member; Liesberg

Figure 1: Various types of thin platy growth forms; note the very muddy nature of the intra-reef sediment. Coin 2.5 cm in diameter.

Figure 2: Cuspate growth forms; note how the plate on the right has overgrown the other plate resulting in partial mortality of the lower coral. Both plates are *Dimorpharaea.* Coin 2.5 cm in diameter.

Figure 3: More domal and tabular growth forms. These are generally subordinate to platy forms though they become increasingly important at the top of the Liesberg biostrome. They are generally *Isastraea.* Pen 14 cm.

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Plate 5.6: Basal biostrome; lower St. Ursanne Formation; St. Ursanne railway station

Figure 1: Panoramic view showing the form and dimensions of the basal biostrome.

Figure 2: Details of the bedded nature of the biostrome.

Figure 3: Boring bivalves drilling into the top surface of a *Microsolena* plate. Height of frame approximately 8 cm.

Figure 4: *Trichites* valve; these are a common element of the associated fauna of this reefal unit. Height of frame approximately 9 cm.

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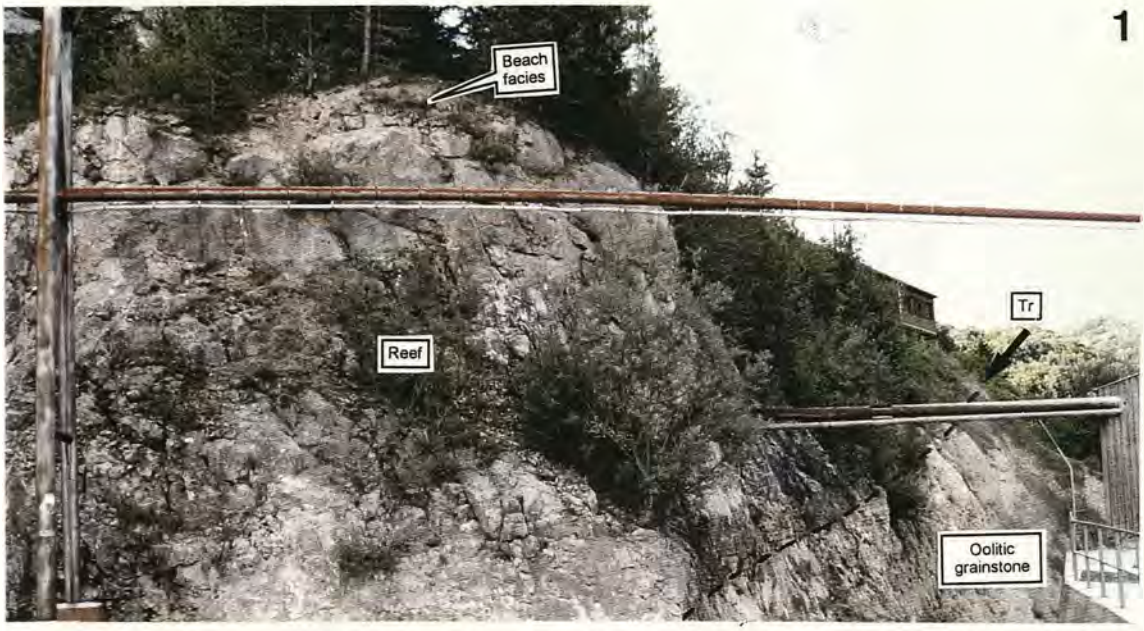
Plate 5.7: Facies and fabrics of the upper patch reefs (patch reef 1); Upper St. Ursanne Formation; St. Ursanne

Figure 1: The main section that exposes patch reef 1 illustrating the location of the reef within the sequence and the facies associated with it. Tr: trangressive surface. Height of frame in the foreground approximately 7 m.

Figure 2: Details of beach facies. Many of the spherical clasts are rolled fragments of coral. The longer cigar shaped clasts are generally highly micritised and coated nerineid gastropods. Bar 0.5 m.

Figure 3: Two large spherical domes of *Stylina* exposed near the top of patch reef 1. Hammer 32 cm.

Figure 4: Thin section through a *Stylina* colony illustrating the characteristic features of the genus (plocoid form; strongly costate; costae sub-confluent to non-conflent; columella present and auricula at the ends of the septa). Diameter of calices 8 mm.



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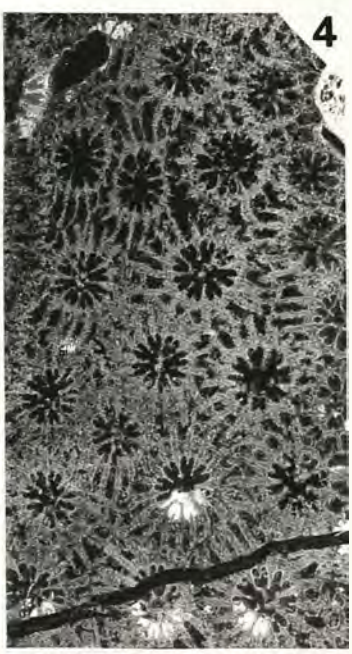

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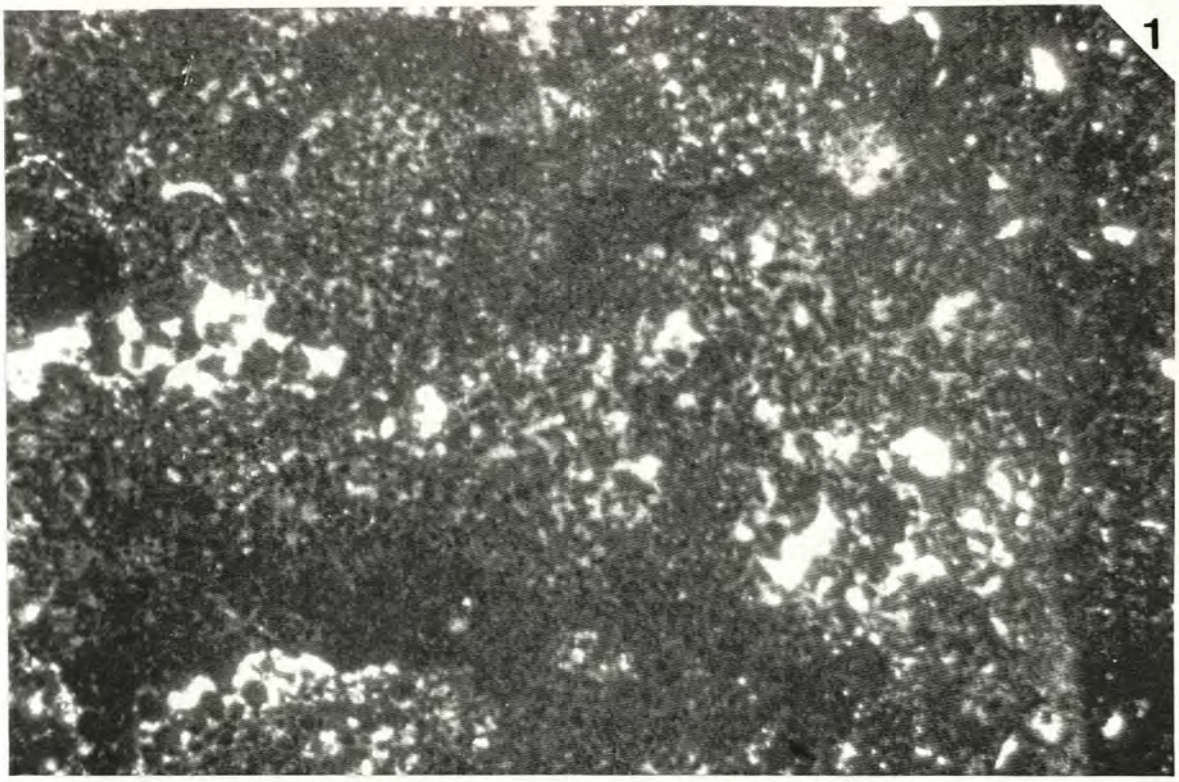
Plate 5.8: Intra-reef sediment microfacies of the upper patch reefs (patch reef 1); Upper St. Ursanne Formation; St. Ursanne

Figure 1-3: Various types of peloidal fabrics that form much of the intra-reef sediment at this locality. These are generally domal to wavy in form and mainly composed of peloids. The peloidal rinds which define the microfabric represent tightly packed aggregates of peloids. Laminated fabric (such as those observed at Bois du Parc and Quatre Pieux, Burgundy) are present though not common. Figure 1, height of frame 4 mm; figure 2 height of frame 3 mm; figure 3, height of frame 2.5 mm.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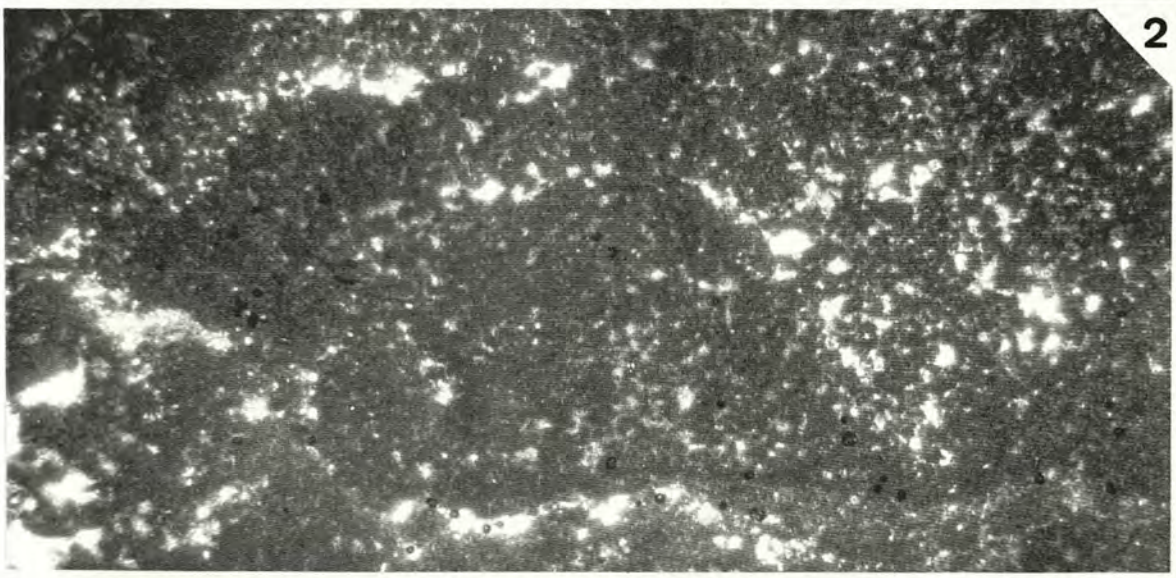
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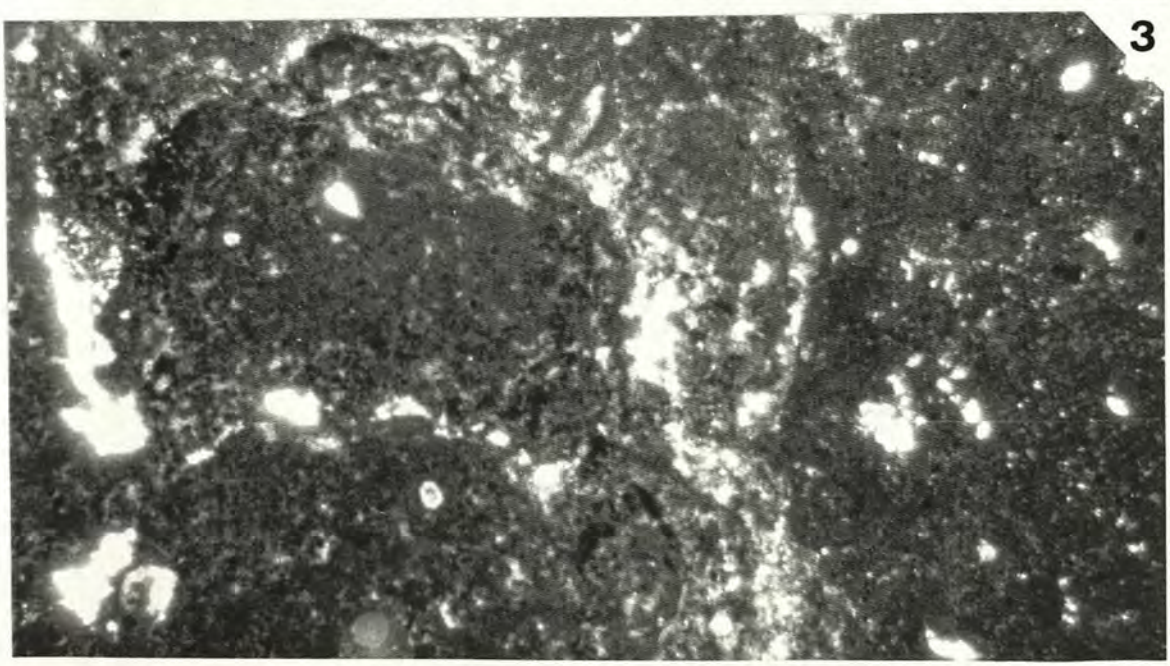
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Plate 5.9: Upper patch reefs (patch reef 2); Upper St. Ursanne Formation; St. Ursanne

Figure 1: Transverse section through an *Aplosmilia* colony which dominates patch reef 2. Note the intensity of small borings around the coral branches. These are predominantly clionid sponge borings although the occasional boring ?foram can be found within these chambers. Also present are a number of unidentified sheet-like encrusters. Branch diameters: 2-4 cm.

Figure 2: Transverse section through a branching ramose *?Meandaraea*. Note the abundant spongiostromate crust around the branches (light gray colour) which is also present in figure 1 and the relative paucity of bioerosion of the branches compared with the phaceloid coral branches in figure 1. Branch diameters: 2-4 cm.

Figure 3: Net-like bryozoan (cf. *Berenicea*) encrusting one of the *Meandaraea* branches in figure 2. Width of frame 2 cm.

Figure 4: Agglutinating serpulids encrusting one of the *Meandaraea* branches in figure 2. Width of frame 1 cm.

All figures are negative prints from thin sections.

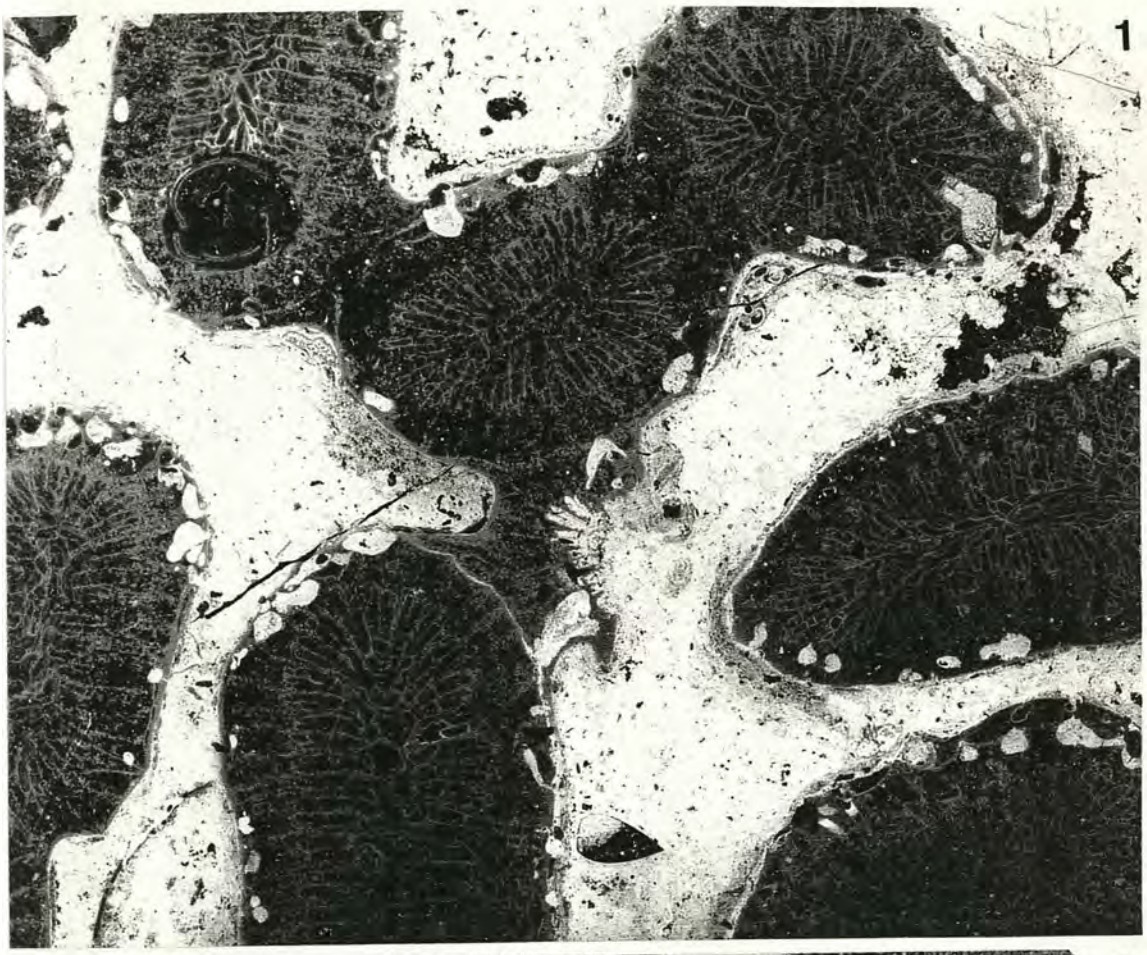
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Plate 5.10: Reef 2; Upper St. Ursanne Formation; south of Courtételle

Figure 1: Form and dimensions of reef 2 at the base of the section. Not internal bedding of the reef and draping of the off reef muds over the reef. The reef sit on a unit of oolitic grainstones which occur just below the path. (Bi): reef; (Bii) inter-reef muds. Height of reef: 5 m.

Figure 2: A nest of terebratulid brachiopods which are abundant in both the reef and off reef facies. Height of frame 6 cm.

Figure 3: Microfacies of the intra-reef sediment of reef 2 which is dominated by rindy microbial biopelmicrites and non-microbial biomicrites (see text for details). Height of frame 2 mm.

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Plate 5.11: Reef 4; Upper St. Ursanne Formation; south of Courtételle

Figure 1: Details of the reef fabric of reef 4, dominated by tabular forms. The large colony to the left of the hammer is *Microsolena*. Hammer 32 cm.

Figures 2-3: Rindy peloidal fabrics of the intra-reef sediments of reef 4. Figure 2, height of frame 4 mm; figure 3, height of frame 1.5 mm. (See text for details.)

Figure 4: Inter-reef sediments: Bioclastic packstones rich in highly micritized and coated bioclasts and lithoclasts; height of frame 5 mm. (See text for details.)

Figure 5: Unit E: Oolitic grainstone rich in large *Plagiostoma* valves. Coin 2.5 cm.

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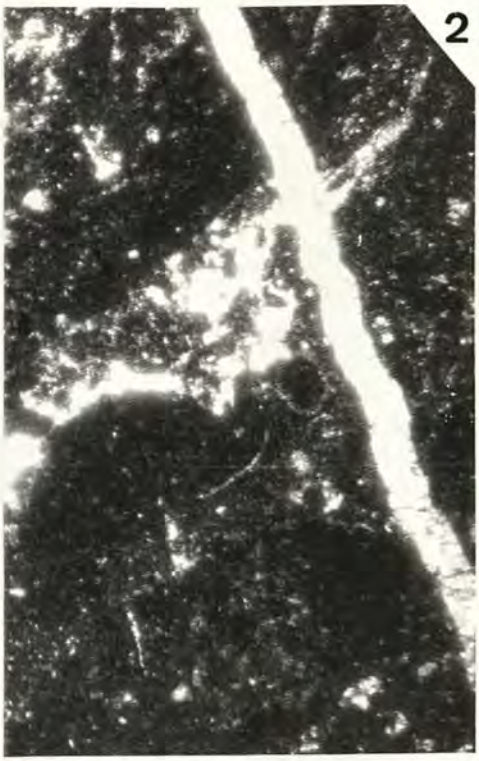

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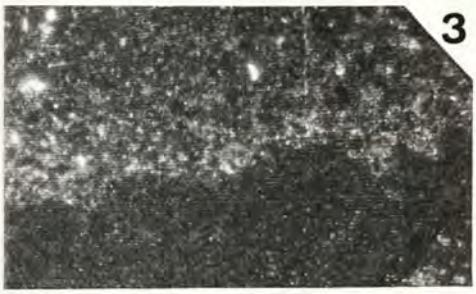

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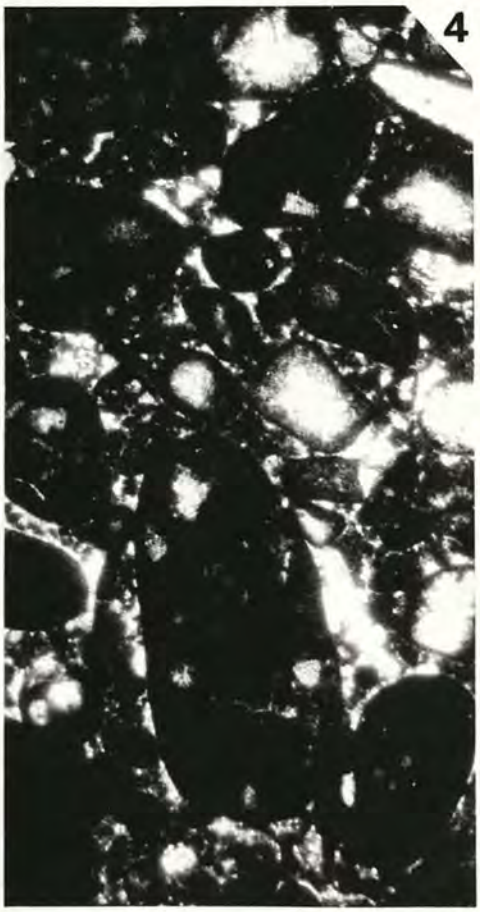

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Plate 5.12: Reef 5; Upper St. Ursanne Formation; south of Courtételle

Figure 1: The transition from the well bedded mudstones of unit G to reef 5.


Unit G:
mudstones
Reef

Plate 5.13: Reef 5; Upper St. Ursanne Formation; south of Courtételle

Figure 1: Form and dimensions of patch reef 5. Height of reef 10 m.

Figure 2: Lateral transition from reef 5 into the muds of unit G.

Figure 3: Interpretive sketch of figure 2.

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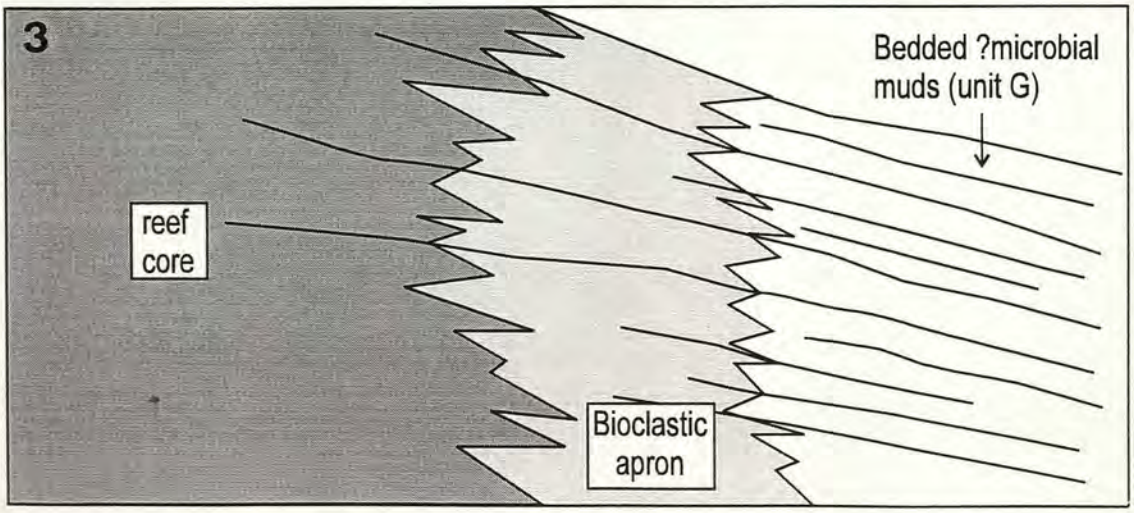

Plate 5.14: General view of the reefal facies and fabric of the Péry-Reuchenette section; Günsberg Member

Figure 1: General view of the outcrop showing the bedding in the inter-reef marl and the reefs (where bedding becomes less distinct). Note the dark nature of the marl which is a consequence of its relatively high siliciclastic clay component. Height of frame approximately 6 m.

Figure 2: Reef fabric composed of long thin platy corals developing on depositional surfaces within the reef. Hammer 32 cm.

Figure 3: Reef fabric composed of branching phaceloid and domal colonies. Height of frame approximately 2 m.

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Plate 5.15: General view of the reefal facies and crust formation of the Péry-Reuchenette section; Günsberg Member

Figure 1: Reef fabric dominated by domal forms. The rounded domal colonies in the centre bottom of the figure have been rolled and are not in situ. Frame height approximately 2.5 m.

Figure 2: Domal colonies encrusted with a dark gray crust which is also visible within the intra-reef sediment. Frame height approximately 1 m.

Figure 3: Close-up of the crusts shown in figure 2. Note that these crusts developed within the intra-reef sediment suggesting rather early cementation of the intra-reef material. Also note the gradation between the non-stained microbial biopelmicrite (light grey) and the knobby dark grey crust (stained) at the top of the figure (arrow). Small fragments of the darker crust within the non-stained microbial biopelmicrite is again suggestive of the early cementation of the crusts. Frame height approximately 10 m.


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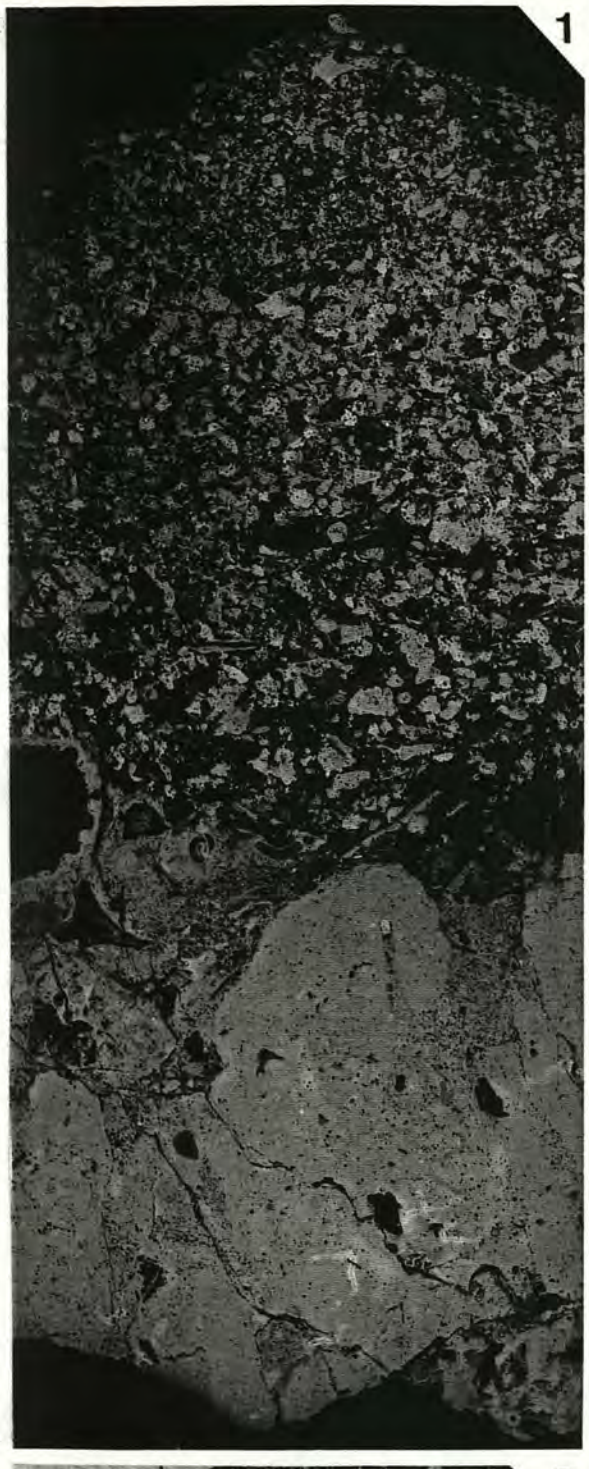
Plate 5.16: Intra-reef microfacies; Péry-Reuchenette section; Günsberg Member

Figure 1: Microbial fabrics (microbial biopelmicrites) terminated by a grainy fining upwards unit. Many of the light grey grain in the upper calcarenite are fragments of peloidal intraclasts derived from fragmentation of lithified crust. Height of frame 6 cm.

Figures 2-4: Details of the microbial columns forming much of the intra-reef sediment. Note in the bottom left hand corner of figure 3 the development of spherical "oncoidal" fabrics. Figure 2: height of frame 6 cm; figure 3 height of frame 1 cm; figure 4 height of frame 1.3 cm;

All figures are negative prints from thin sections.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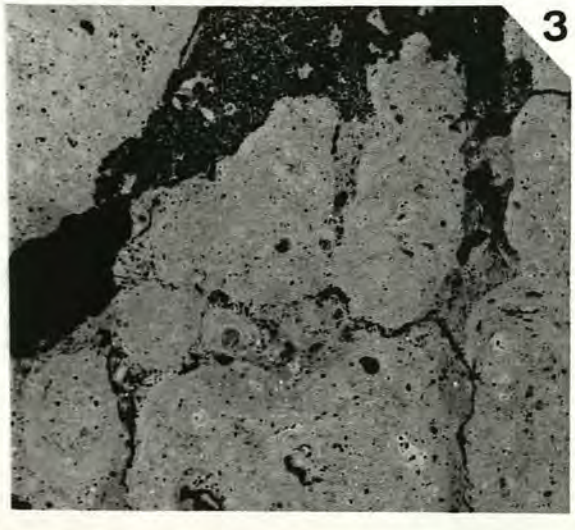
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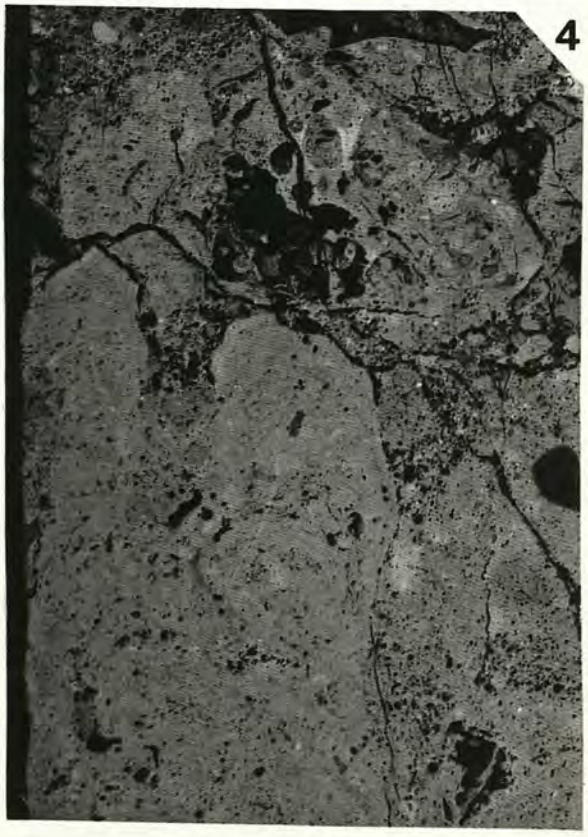
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Plate 5.17: Knobbly crust formation; reef facies; Péry-Reuchenette section; Günsberg Member

Figures 1-2: Development of knobby crusts on erosional surfaces (figure 1) and coral branches and fragments (figure 2). Note in figure 1 the encrustation of the knobby crusts by serpulids and other problematic organisms (see figures 3 and 4). Height of frame for both figures 4 cm.

Figure 3: Unidentified chambered encruster which itself has been encrusted by spongiostromate crusts. Height of frame: 2.5 mm.

Figure 4: Close up of a problematic encruster in figure 1. *Koshirobulia socialis*. Height of frame: 2.5 mm.

All figures are negative prints from thin sections.


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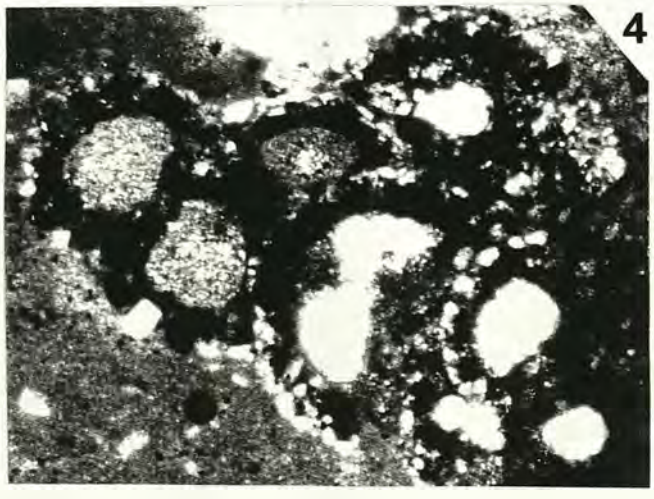
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Plate 5.18: Encrusted branching phaceloid colony; reef facies; Péry-Reuchenette section; Günsberg Member

Figure 1: Transverse section through a colony of *Calamnophylliopsis* encrusted by microbial crust. The sediment inbetween the branches is either microbial biopelmicite or structureless biopelmicrite. Branch diameter: 2-4 cm.

Figures 2-3: Details of organisms encrusting the coral branches. Net-like bryozoan (figure 2); serpulids and *Nanogyra* (figure 3). Figure 2: central branch is 2.3 cm at its widest; figure 3: branch diameter 3 cm.

All figures are negative prints from thin sections.


1


2


3

Plate 6.1: Reef and associated facies; Haydon Wick, Wiltshire; England.

Figures 1-2: Figures showing the rubbly appearance of the reef facies. Figure 2 shows the association of clay seams, biosparites (light grey material to the upper right of the hammer) and coral colonies of the Haydon Wick coral-bearing limestones.

Figure 3: Details of one of the clay seams; note the inclusion of echinoid spines (white specks) within the clay seam.

Hammer 32 cm.

1

2

3

Plate 6.2: Facies; Haydon Wick, Wiltshire; England.

Figure 1: Inter-reef facies: oncobiosparite; width of frame: 4.5 mm. (See text for details).

Figure 2: Intra-reef facies: *Rhaxella* biomicrite; width of frame: 4.5 mm. (See text for details).

Figure 3: Faecal pellets which can be common in the intra-reef sediments; width of frame: 2 mm

Figures 4-5: Small encrusters within the spongiostromate crusts. Figure 4, width of frame: 2 mm; figure 5, width of frame: 0.8 mm.


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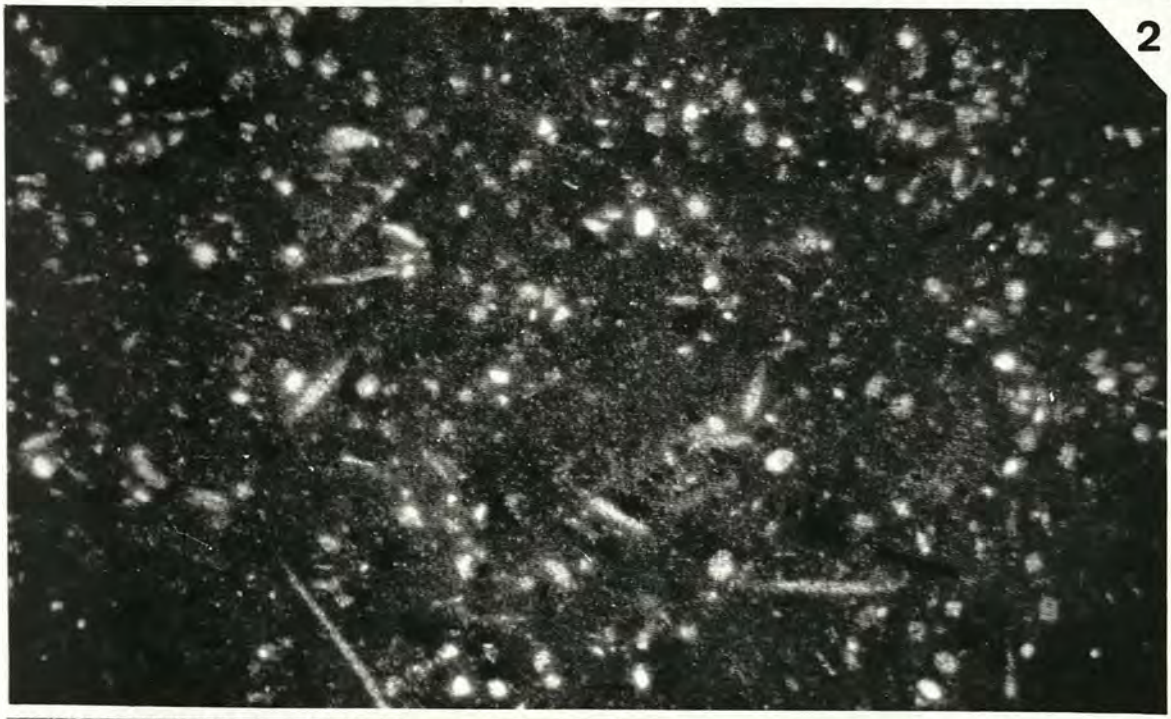
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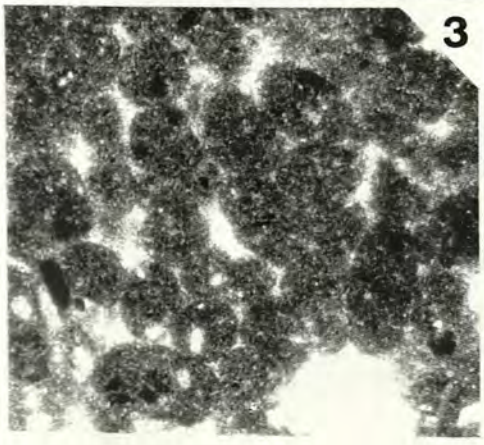
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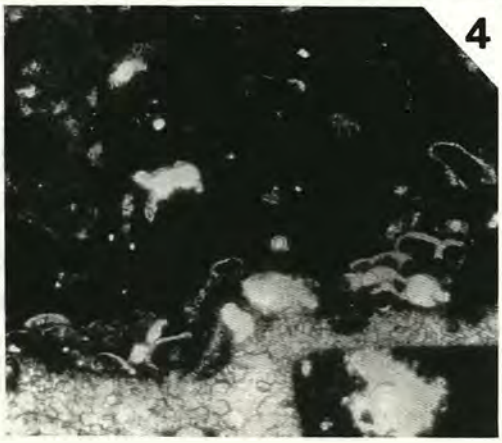
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Plate 6.3: Knobbly spongiostromate crusts; Haydon Wick, Wiltshire; England.

Figures 1-2: Figure 1, a *Thecosmilia* colony completely encrusted by knobbly spongiostromate crusts. Note that very little of the coral skeleton can be seen; pen 15 cm. Figure 2, surface details of the knobbly spongiostromate crust; width of frame 5 cm.

Figure 3: Transverse section through a crusted *Thecosmilia* branch. Negative print through thin section; width of frame: 2 cm.


1


2


3

Plate 6.4: Knobbly spongiostromate crusts; Haydon Wick, Wiltshire; England.

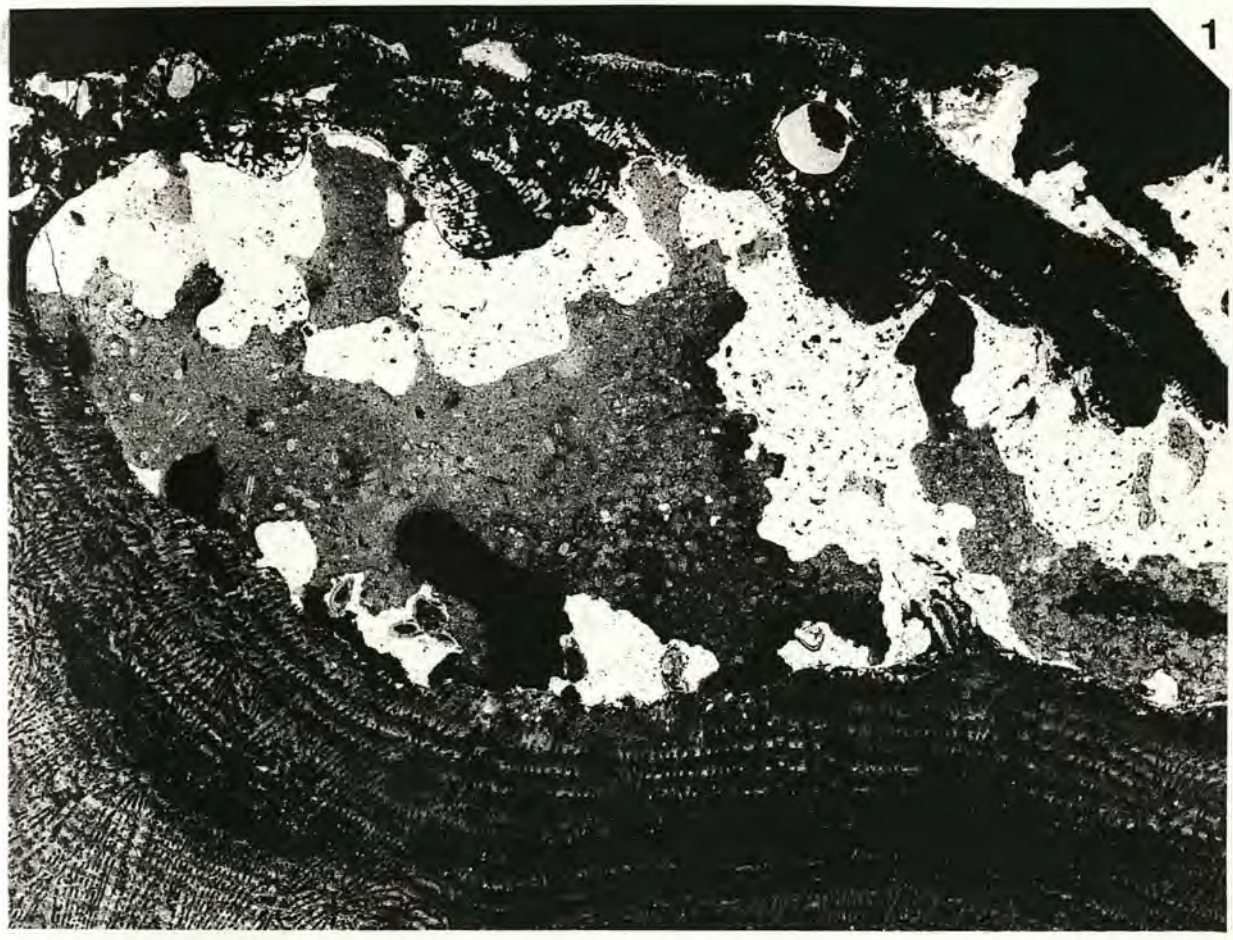
Figures 1-2: Transverse sections through crusted *Thecosmilia* branches. Width of frames: 2.5 cm.

1

2

Plate 6.5: Knobbly and planar spongiostromate crusts; Haydon Wick, Wiltshire; England

Figures 1-2: Figure 1, Crust development on massive colonies. Also note the well developed growth bands in the bottom *Thamnasteria* colony; width of frame: 5 cm. Figure 2, Heavily crusted foliaceous *Thamnasteria* colony and echinoid spine; width of frame: 4 cm.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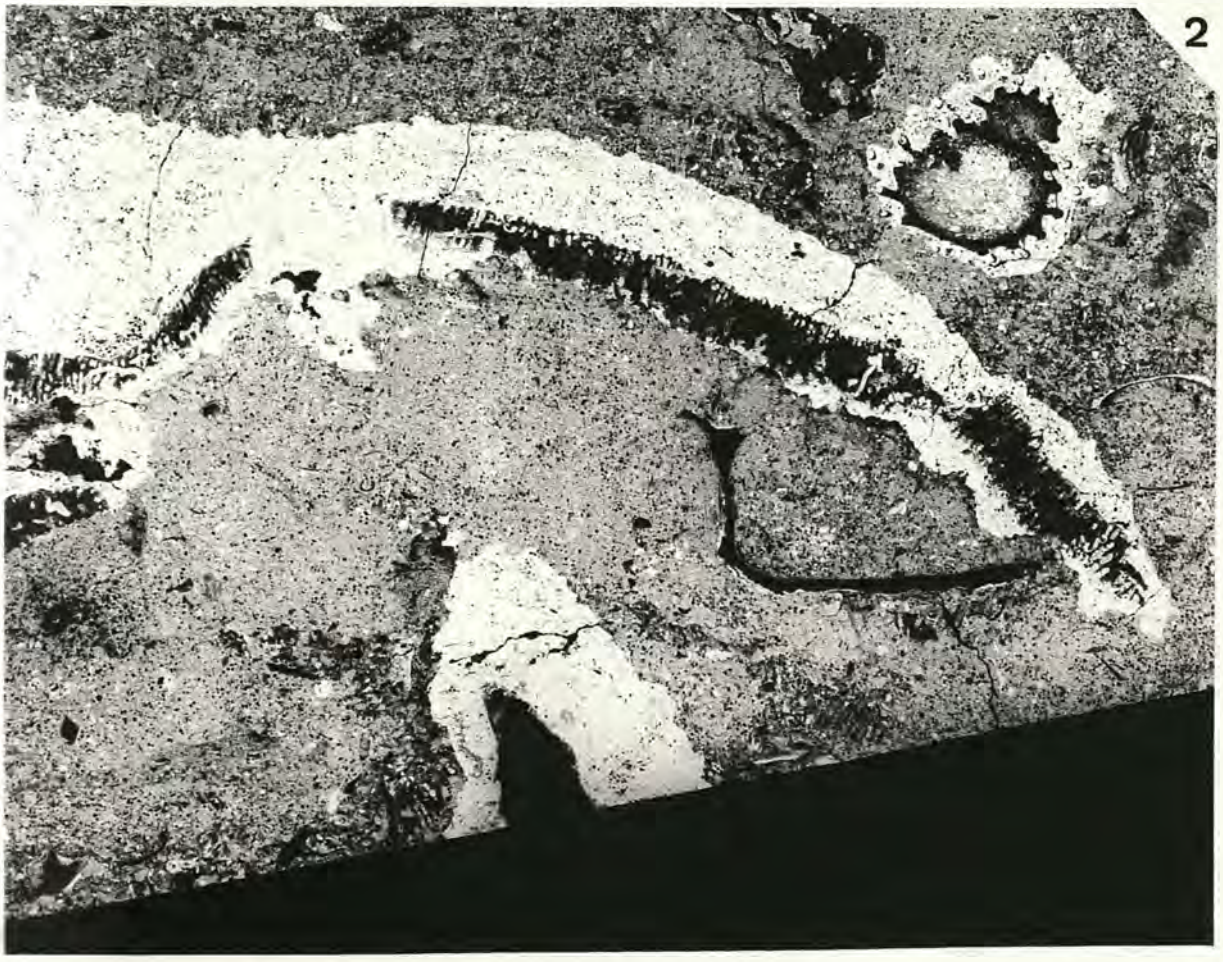
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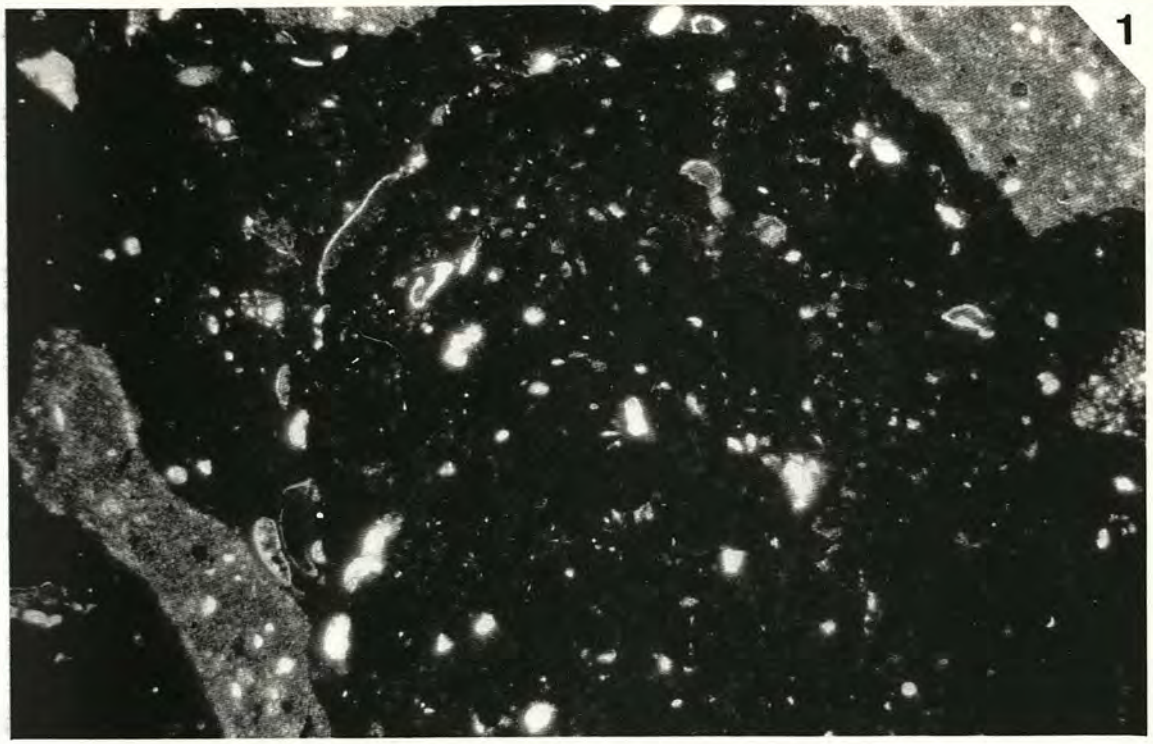
Plate 6.6: Details of the internal structure of the spongiostromate crusts; Haydon Wick, Wiltshire; England

Figures 1-3. Sections through spongiostromate knobs showing their clotted peloidal fabric and vague growth increments. The growth increments are defined by the inclusion of fine bioclastic material, occasional encrusters, and variations in the density of the clotted microfabric.

Width of frames: 2 mm.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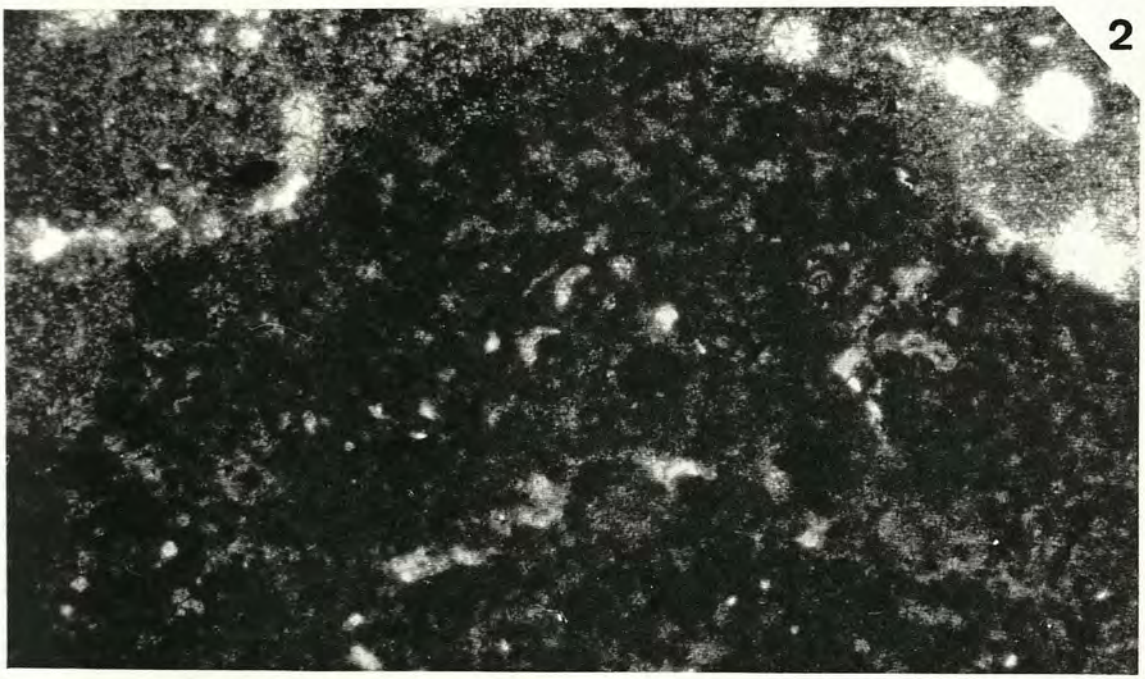
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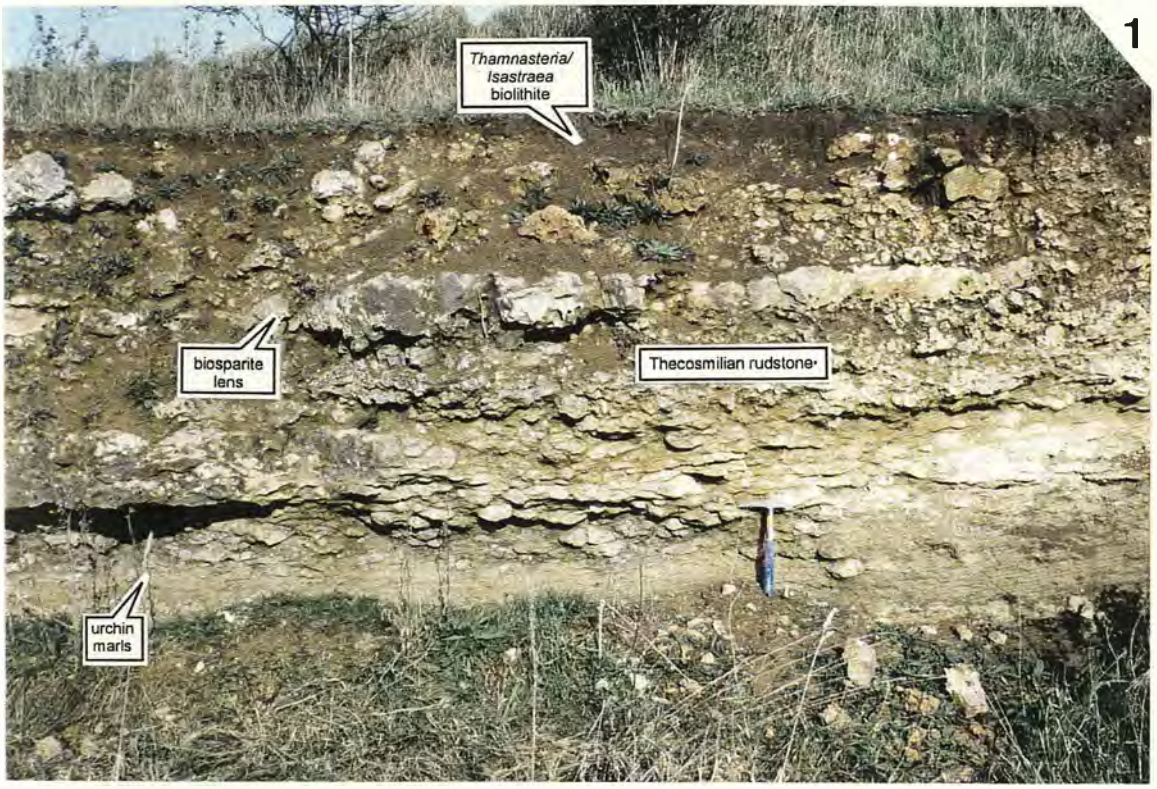
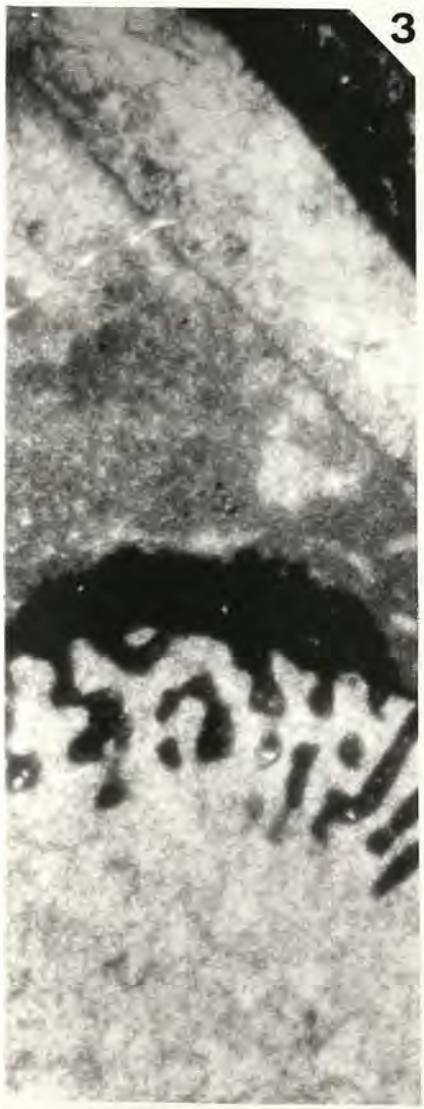
Plate 6.7: Shellingford Cross-Roads Quarry, Oxfordshire; England.

Figure 1: Facies sequence within the coral-bearing limestones; hammer 32 cm.

Figure 2: Details of the upper part of the section showing a biosparite lens with the mould of a small in situ *Thecosmilia* colony. Above the biosparite lens is a thin unit of thecosmilian rudstone, which is followed by the *Thamnasteria/Isastraea* biolithite with a large, low domed *Thamnasteria* colony. Larger scale in inches.

Figure 3: Photomicrograph showing a thin spongiostromate crust on a *Thamnasteria* colony. These crust are very rare when compared with the reefal units at Haydon Wick. Width of frame: 1.5 mm.


1
Thamnasteria/
Isastraea
biolithite
biosparite
lens
Thecosmilian rudstone
urchin
marls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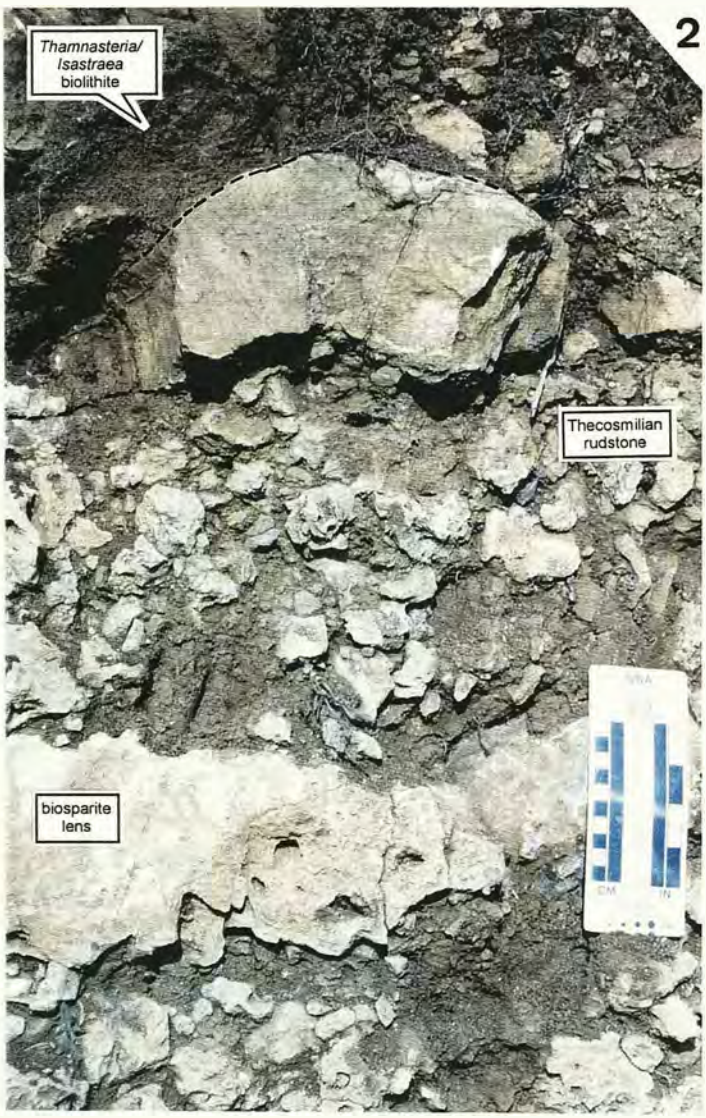

2
Thamnasteria/
Isastraea
biolithite
Thecosmilian
rudstone
biosparite
lens

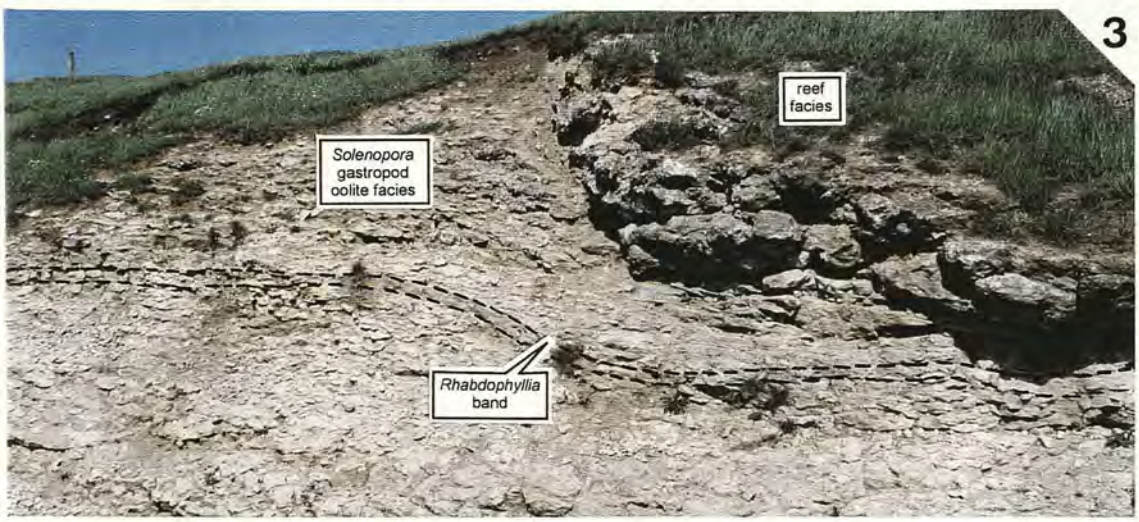
Plate 6.8: Reef fabric and facies; Upware, Cambridgeshire and Ayton, Yorkshire; England.

Figure 1: Reefal fabric at Upware which is dominated by platy colonies; height of pen 15 cm.

Figures 2-4: Reefal patches of the Betton farm outcrop (Ayton). Figure 2, general view of the outcrop, field of view 20 m. Figure 3, lateral and basal contact of the reef facies with the inter-reef oolite facies (*Solenopora*-gastropod facies of the upper Malton Oolite). Note how the reef has sunk into the oolites producing a local dip of the inter-reef sediments into the reef; width of frame 8 m. Figure 4, Details of the reefal patches which are effectively monospacific patches of *Thamnasteria* (only one small colony of *Isastraea* has been found); hammer 32 cm.


1


2


reef facies
Solenopora gastropod oolite facies
Rhabdophyllia band
3


4

Plate 6.9: Facies associated with reef development; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

Figures 1-3: "Back-reef" lagoonal facies. These are dominated by well bedded pelmicrites (figure 1; hammer 32 cm) with well developed laminated fenestrate textures (figure 2; height of frame: approximately 10 cm). Figure 3, photomicrograph of the laminated pelmicrite with fenestrate textures; width of frame: 4 mm.

Figure 4: Biointrasparite from the back reef sand facies; width of frame: 4 mm.

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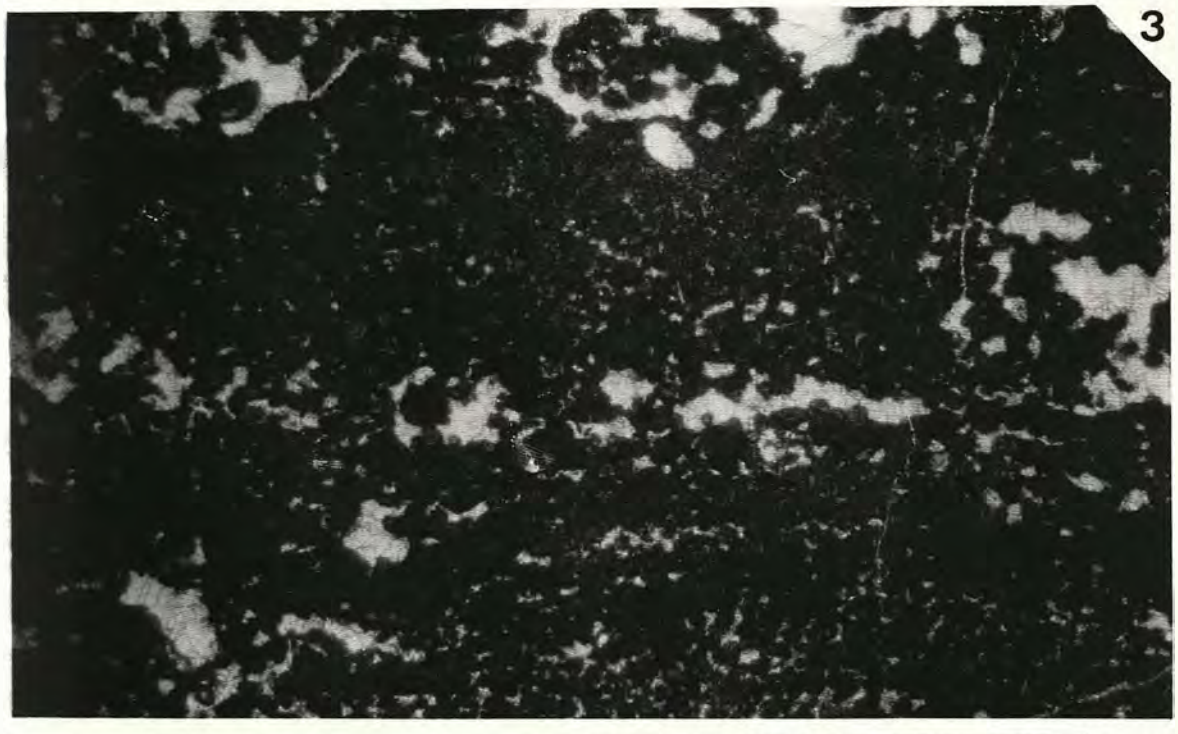

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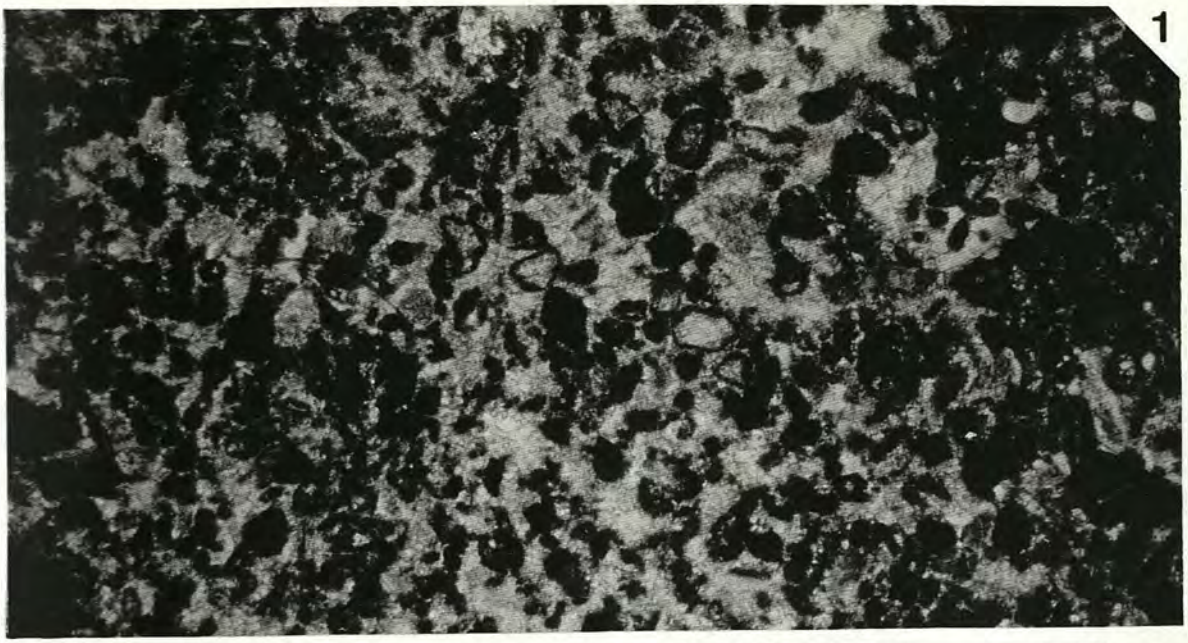
Plate 6.10: Intra-reef sediment microfacies; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

Figure 1: Biointrasparite intra-reef facies; seaward zone; width of frame: 4.2 mm. (See text for details).

Figure 2: Pelbiomicrite intra-reef facies; lagoonward zone; width of frame: 4.2 mm. (See text for details).

Figure 3: Upper part of an oncoid with a ?chaetetid or ?calcified cyanobacteria nucleus and spongiostromate cortex. Locally these microbial oncoids develop up to 1.5 cm across and are set in a sparitic cement (oncoidal grainstones). Lagoonward zone; width of frame: 4.2 mm.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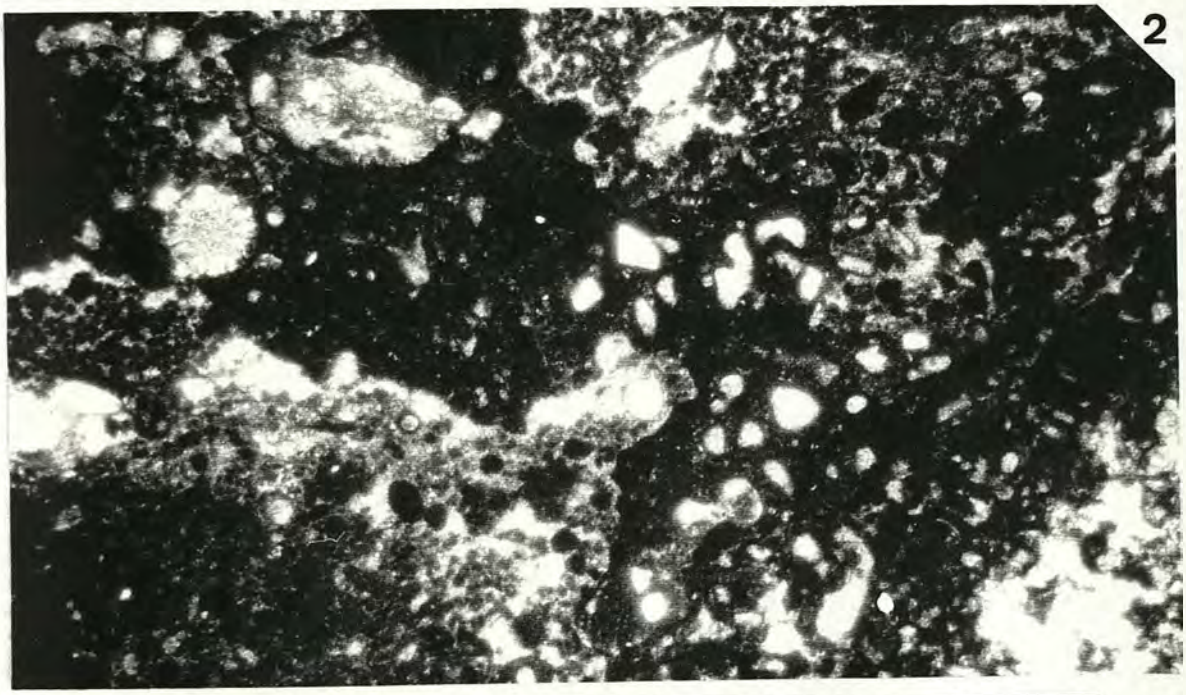
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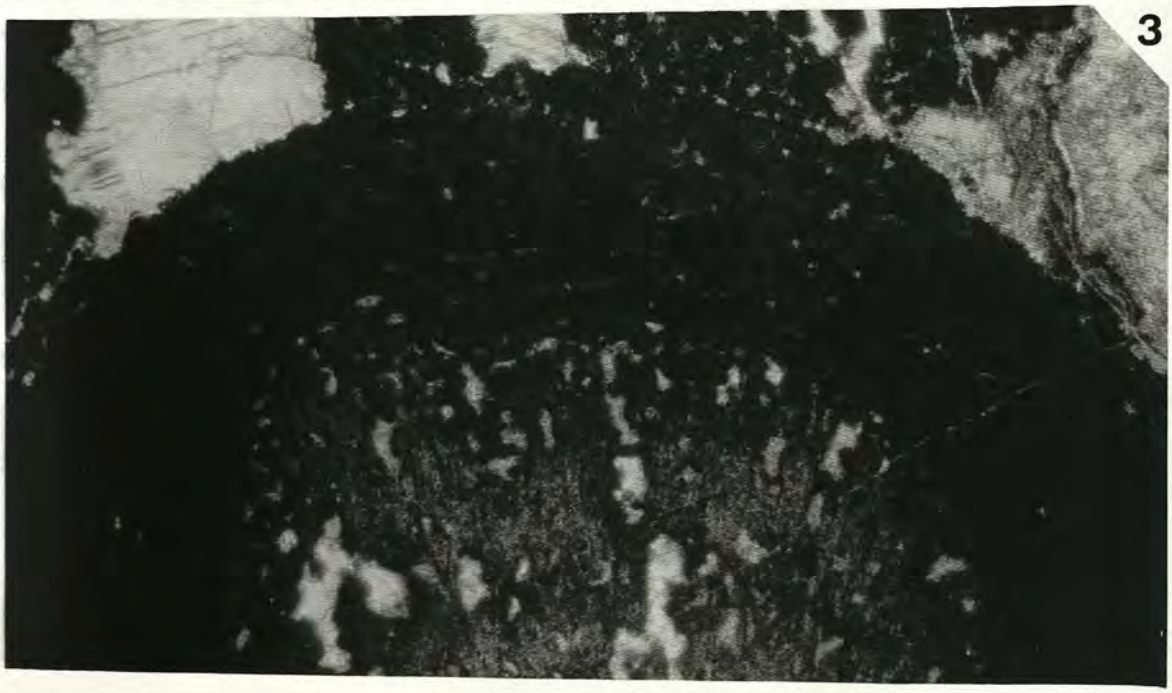
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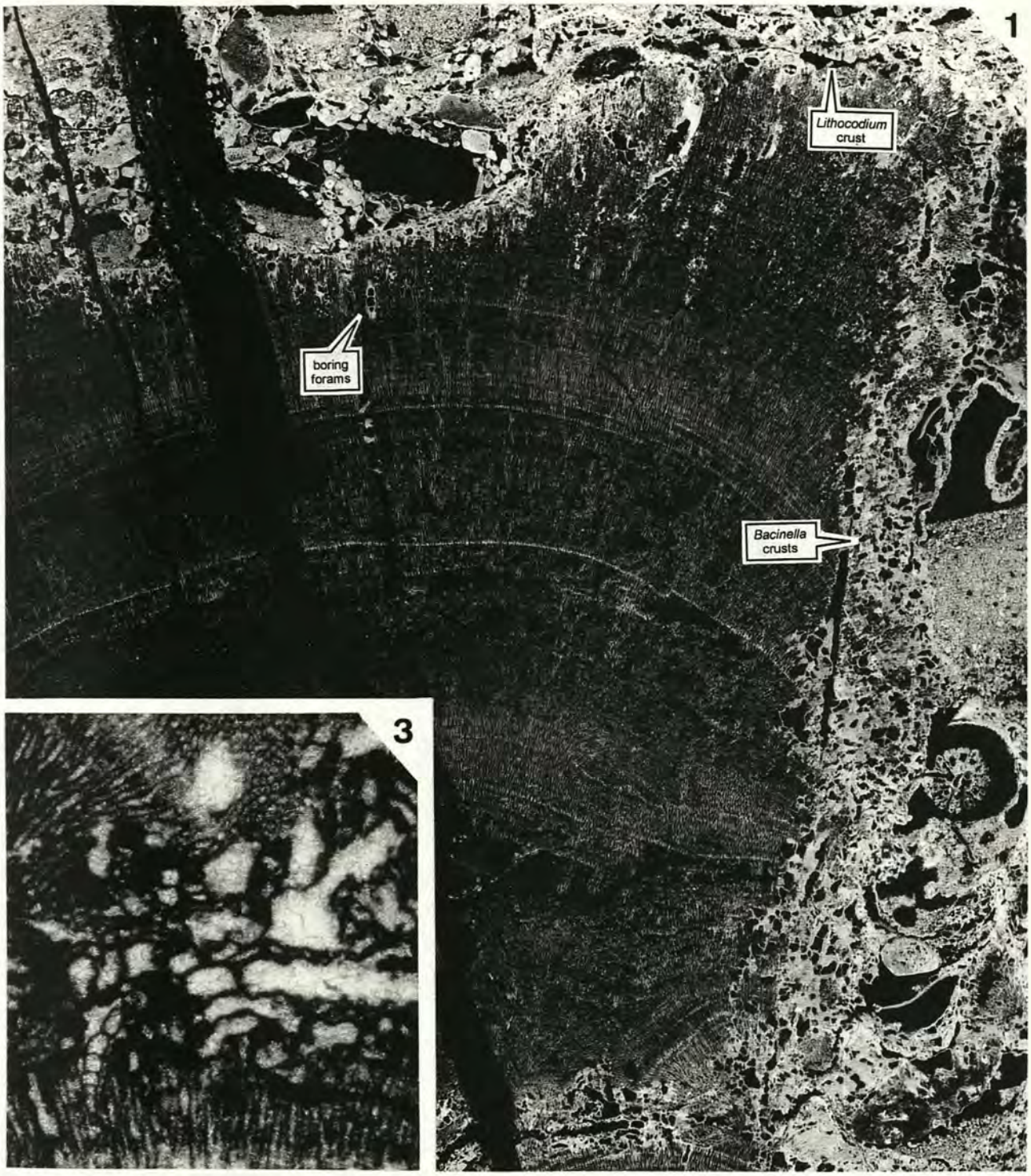
Plate 6.11: Intra-reef encrusted microfabric; lagoonward zone; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

Figure 1: Thin section showing the richness of microencrusters and borers around a chaetetid fragment. The vesicular texture around the right side of the chaetetid is mainly the problematic encruster *Bacinella irregularis* (see figures 2-3). Note the ragged top surface of the chaetetid which has been bored by numerous forams (see plate 6.12). Width of frame 3 cm; negative print from thin section.

Figures 2-3: Details of the problematic encruster *Bacinella irregularis* encrusting the chaetetid; note the maggot-like borer in the bottom left of the figure 3. Width of frames: figure 2: 4 mm; figure 3: 2.5 mm.


1
Lithocodium crust
boring forams
Bacinella crusts

3

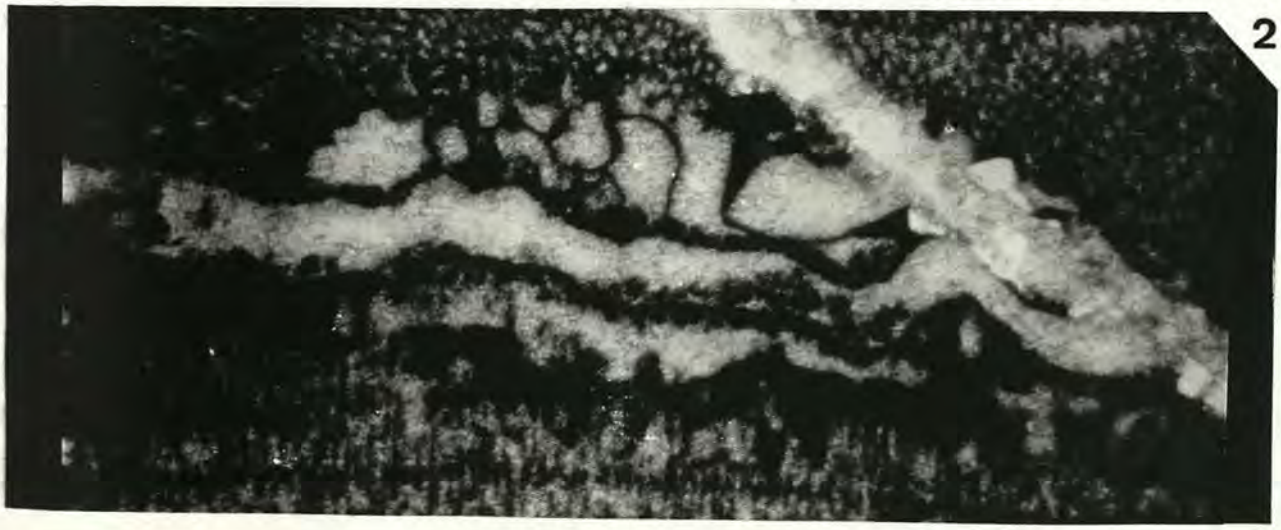

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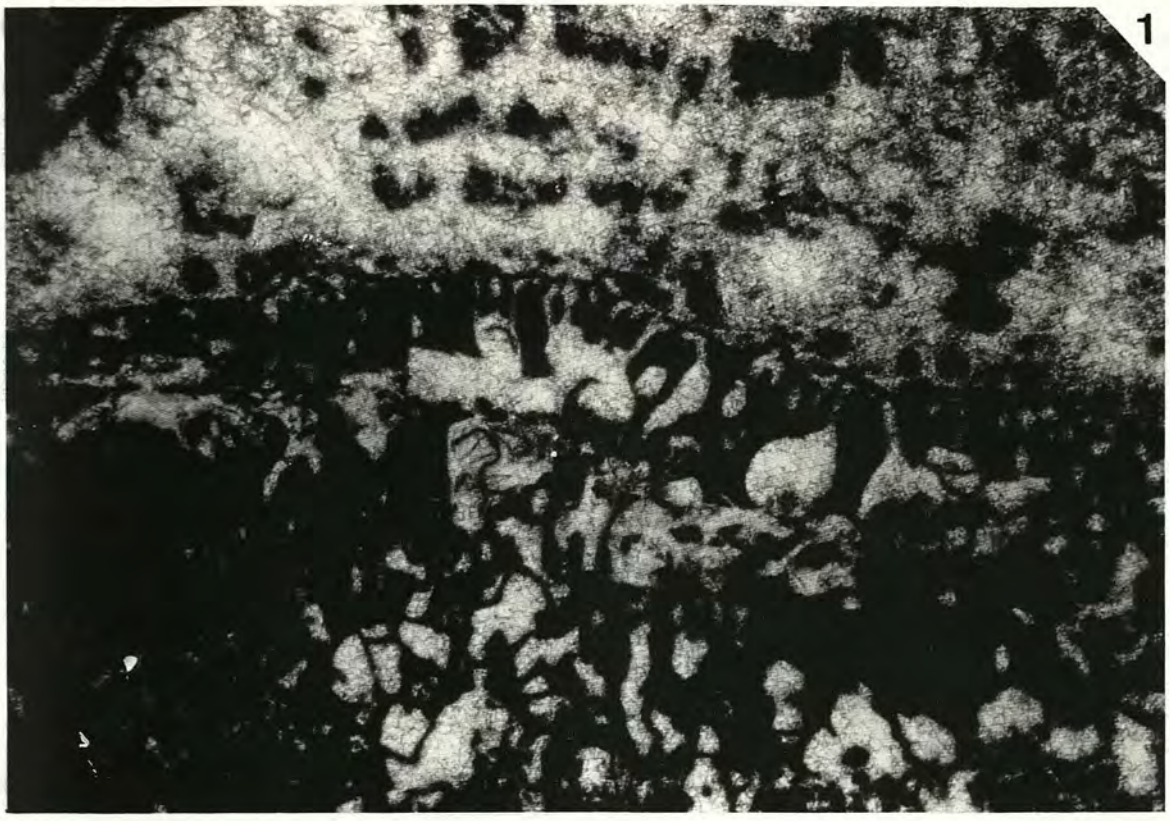
Plate 6.12: Encrusters; lagoonward zone; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

Figure 1: *Lithocodium* sp.; width of frame: 4 mm.

Figure 2: ?*Neuropora*; width of frame: 4 mm.

Figure 3: ?*Koskinobulina* or *Colospongia* (sphinctozoan); width of frame: 1.2 mm.

Figure 4: Nubeculinid foraminifera coated by spongiostromate crusts ("*Tubiphytes*"); width of frame: 1.5 mm.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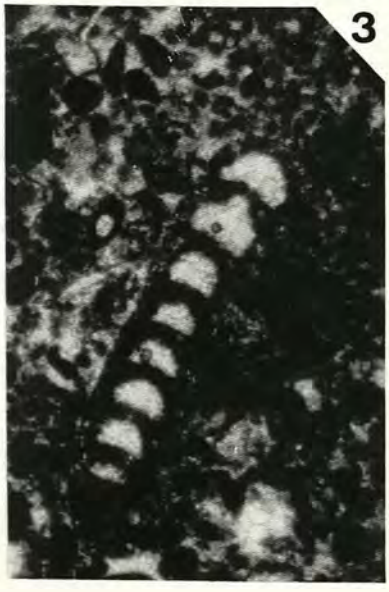
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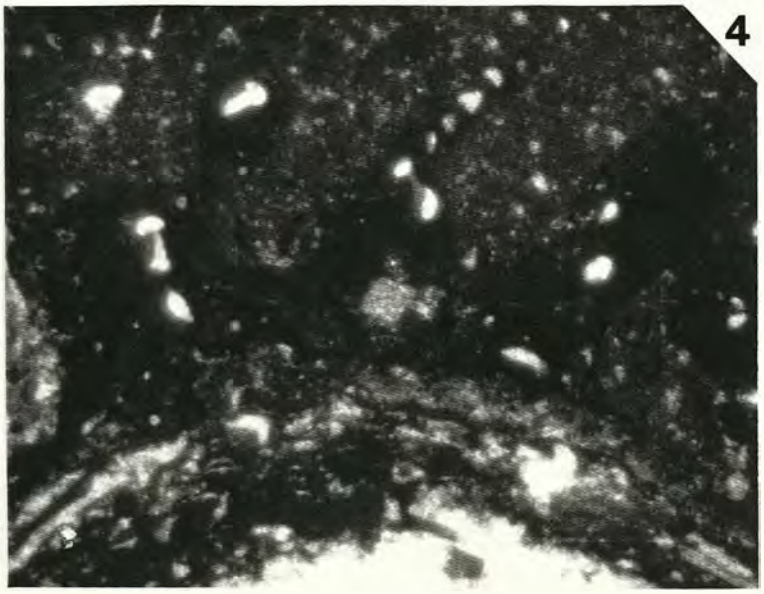
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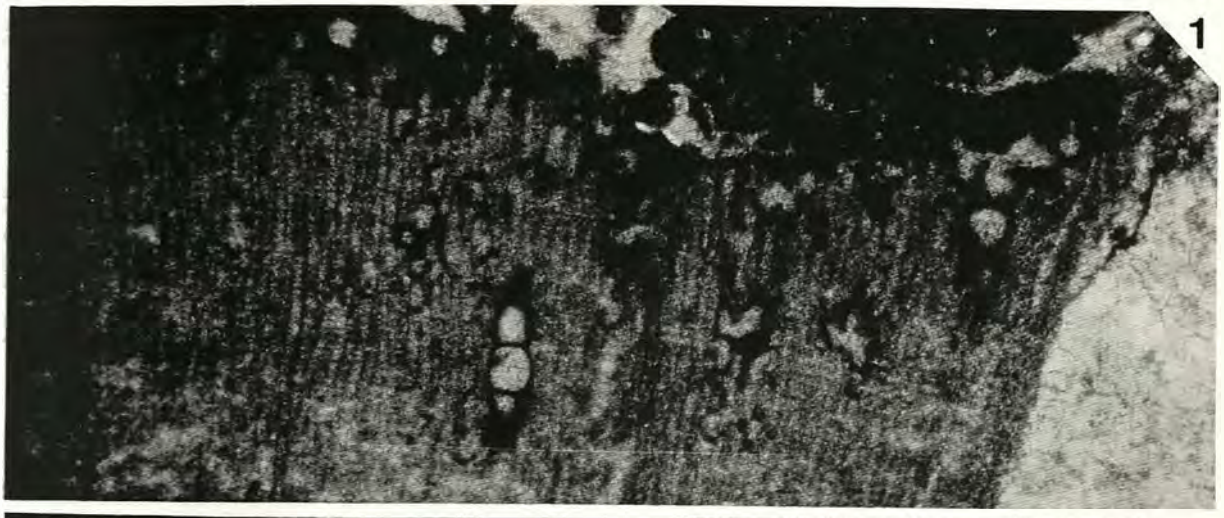
Plate 6.13: Boring foraminifera; lagoonward zone; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

Figures 1-3: Details of the outer surfaces of the chaetetid show in plate 6.11 which is bored by numerous small boring forams cf. *Bullopora*. Width of frames: 4 mm.

Figures 4-5: Details of the boring forams; width of frames: figure 4: 0.4 mm; figure 5: 0.5 mm.

Figure 6: Fully grown *Bullopora* residing within a pre-existing cavity; width of frame: 1 mm.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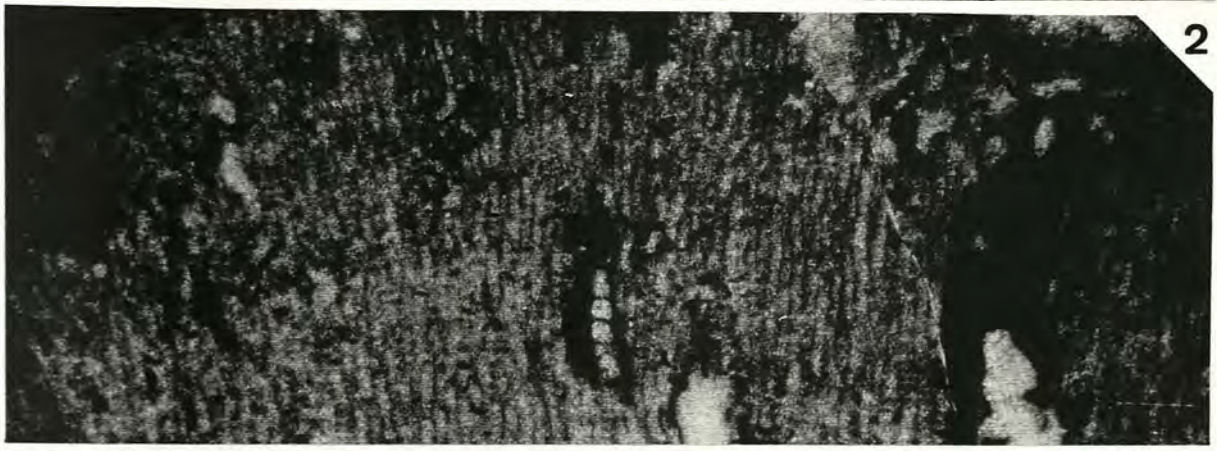
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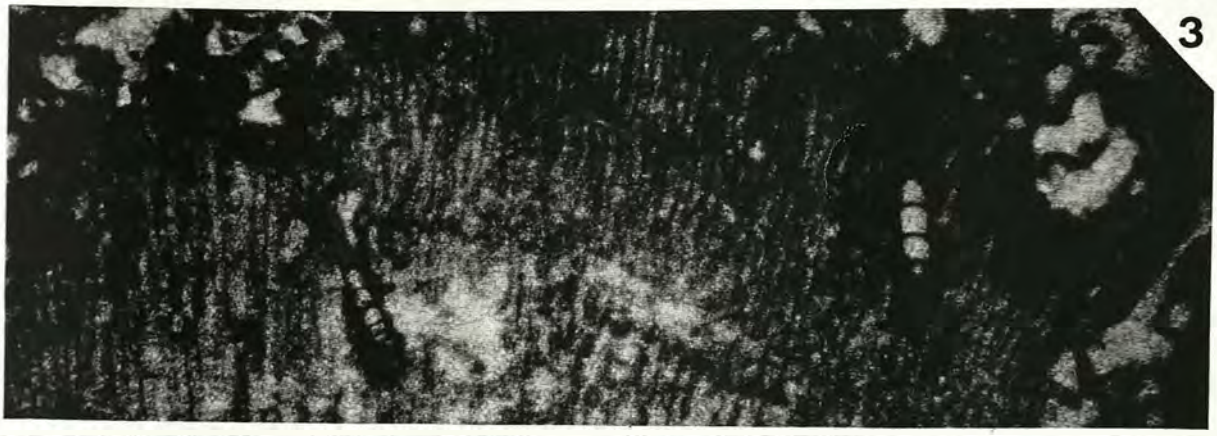
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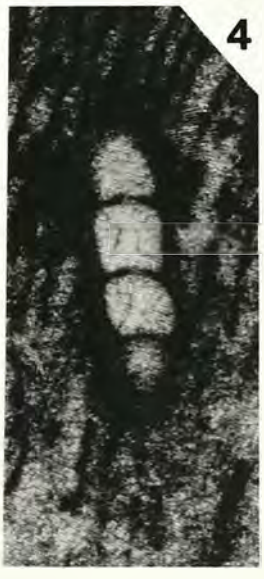
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Plate 6.14: Coral fauna; Al Faro reefs; Polcenigo-Mezzomonte; Friuli, north-east Italy.

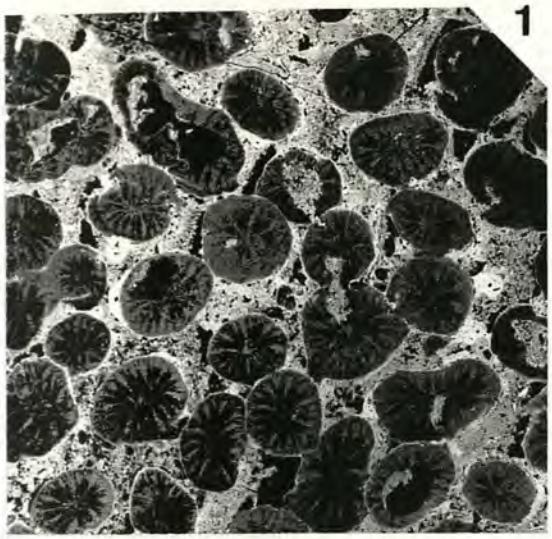
Figures 1-2: The phaceloid coral ?*Placophyllia*; lagoonward zone; width of frame: 2.4 cm. Figure 2, calicular structure; width of frame: 0.9 cm.

Figure 3: *Microsolena*; lagoonward zone; width of frame: 5 cm.

Figure 4: ?*Complexastraea*; lagoonward zone; width of frame: 3.4 cm.

Figure 5: *Stylina*; seaward zone; width of frame: 1.6 cm.

Negative prints from thin section.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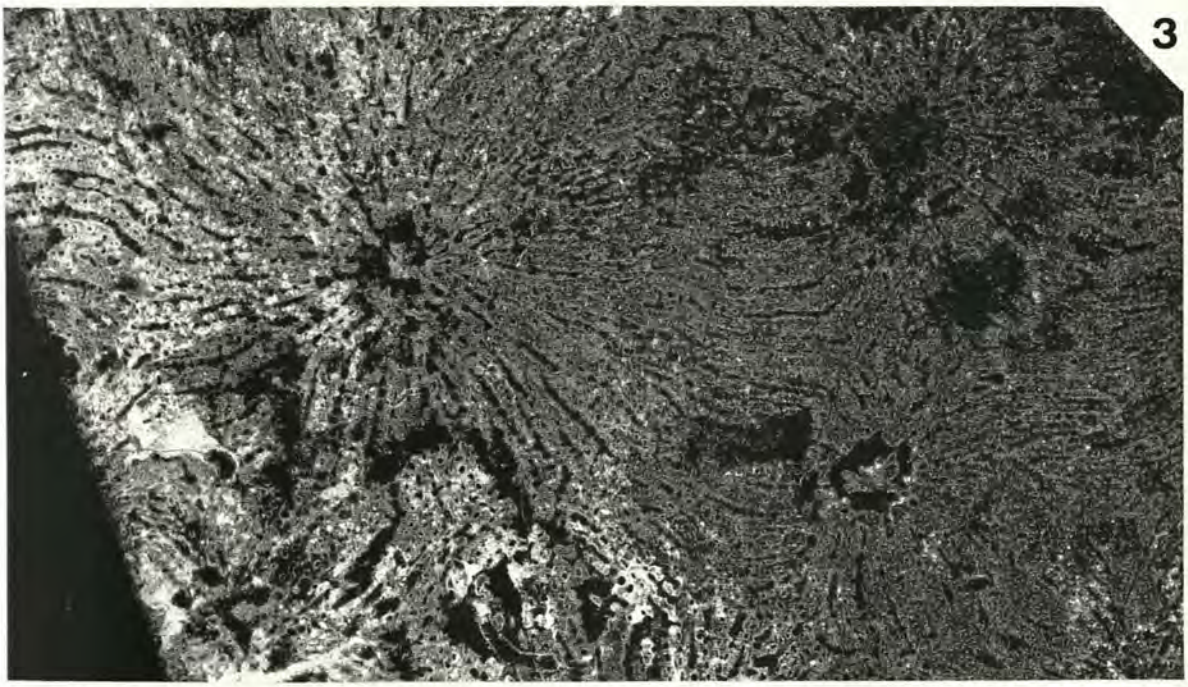
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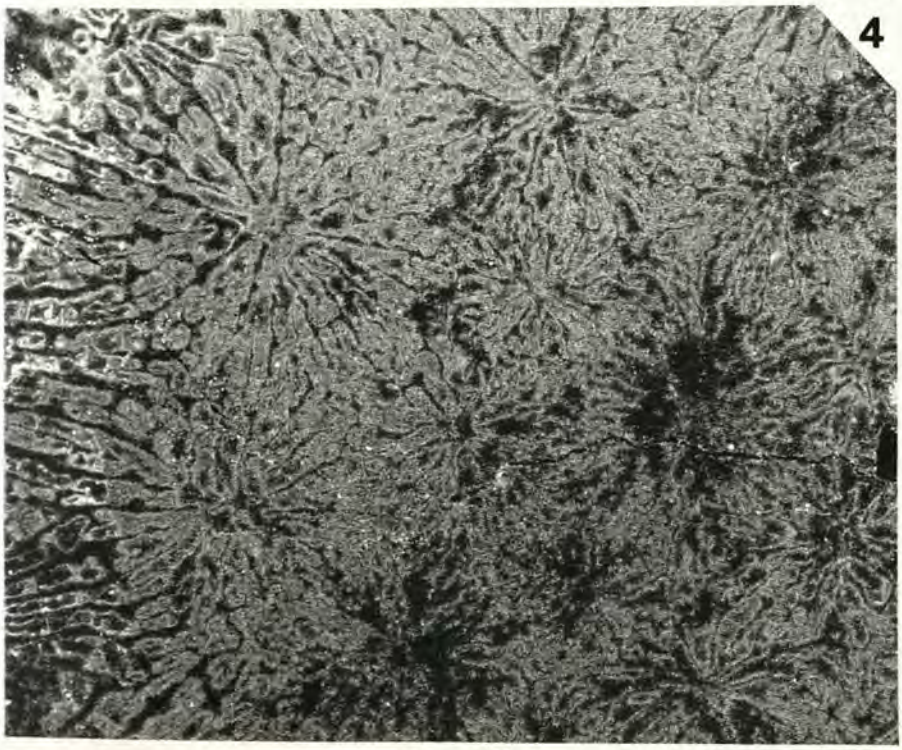
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Plate 7.1: Microsolenid coral structure: Longitudinal sections.

Figure 1: *Microsolena* sp. with well developed and regularly spaced pennulae which is a very characteristic feature of the microsolenids. Foug, coral marl, Lorraine (thin section; scale bar 3 mm).

Figure 2: Details of pennulae in figure 1 (scale bar 1 mm).

Figure 3: Details of pennulae with inter-septal space infilled with early marine peloidal cements. *Microsolena* sp., Liesberg, Swiss Jura (thin section; scale bar 1 mm).

Figure 4: Local fusion of pennulae to form connections between septa (menianae) in a similar fashion to dissepiments. *Microsolena* sp., Châtel-Censoir, Burgundy (thin section; scale bar 3 mm).

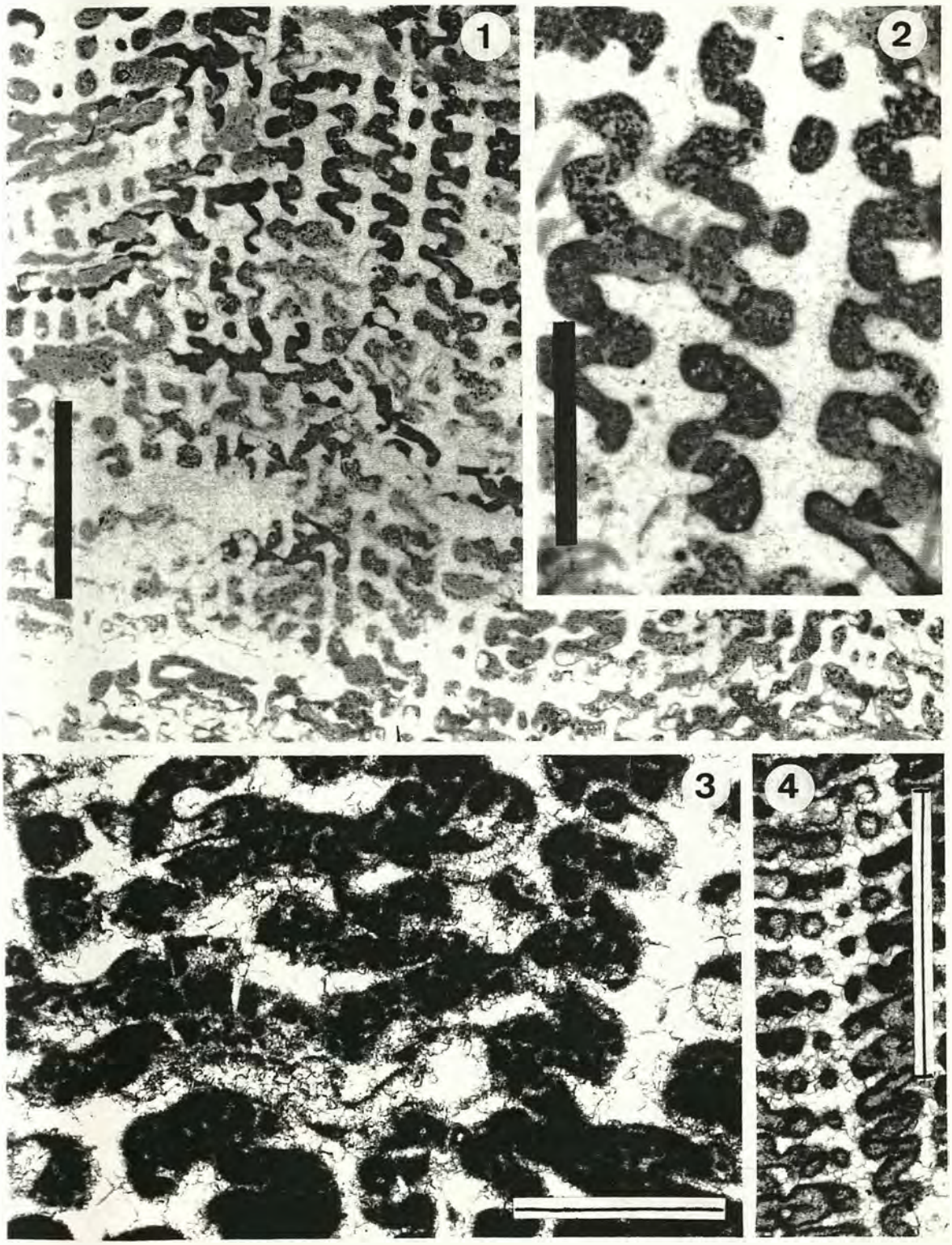
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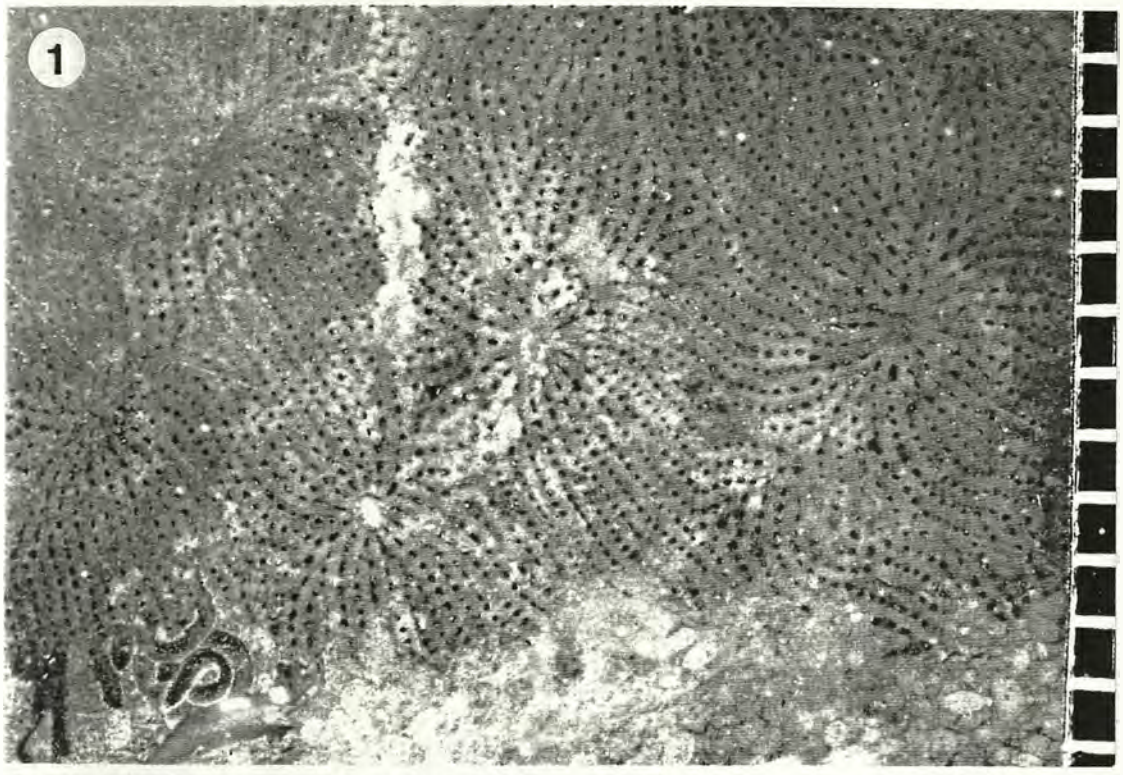
Plate 7.2: Coral structure of the microsolenids and extant *Leptoseris*.

Figures 1-2: Figures illustrating the characteristic features of the microsolenids in tranverse section which are: the thamnasterioid arrangement of calices; the well developed perforate septa; the lack of corallite wall; and the poorly developed columella. Skeletal material is represented by the dark dots (trabecula rods). Fugure 1, *Microsolena* sp., traverse section. Upware, Cambrigeshire (polished slab; scale bar in mm); figure 2, *Dimorpharaea* sp., traverse section. Foug, coral marl, Lorraine (polished slab; scale bar 4 mm).

Figure 3: *Leptoseris foliosa* (Dinesen), oblique section. Note lateral septal projections (pennulae) which are very similar to those in microsolenids (compare with plate 7.1). A number of pennulae have fused together to form a continuous lateral ridge (menianae). (Scale bar 1 mm). Great Barrier Reef. Figure courtesy of Jill Darrell (The Natural History Museum, London).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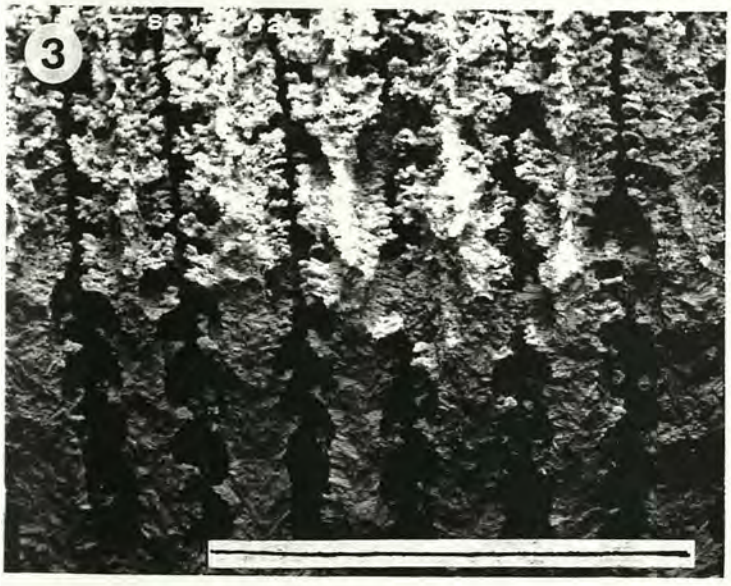
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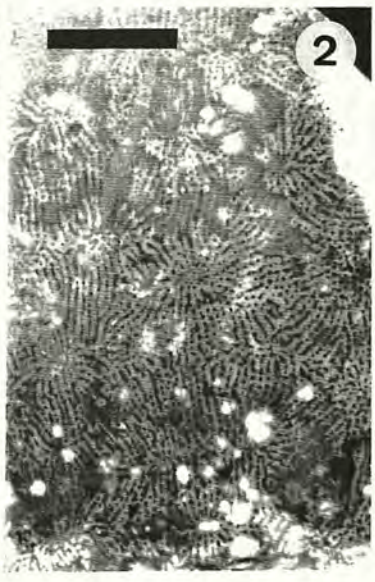
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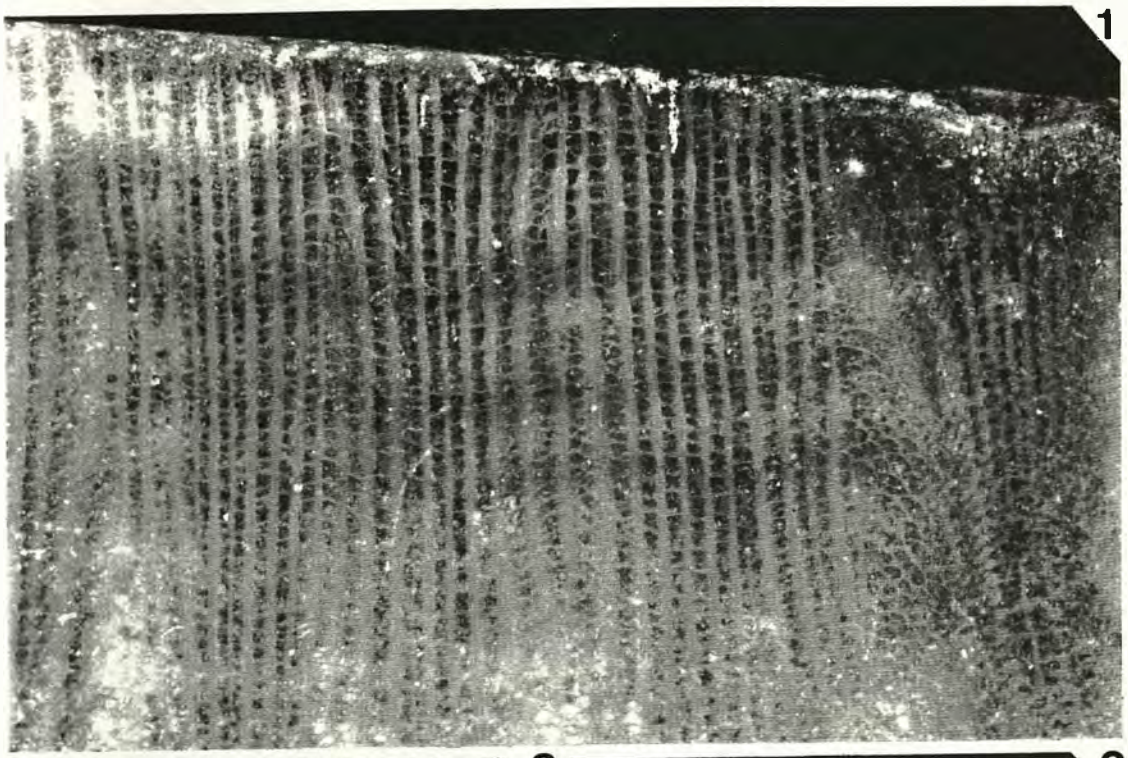
Plate 8.1: Coral growth banding as seen on polished slabs

Figures 1-2: *Isastraea explanata*. Liesberg Member, Liesberg, Swiss Jura; polished slab from a deep-water microsolenid biostrome (type II reef). Figure 1, growth banding defined by high- (light) and low- (dark) density bands; growth rate approx. 2.7 mm/yr; × 7. Figure 2, details of the high and low density bands shown in figure 1. In the high-density band, most septa are thicker with more numerous and closely spaced dissepiments. In the low-density band, the septa are less well developed with fewer dissepiments; × 9.

Figure 3: *Thamnasteria concinna*. Coral Rag, Shellingford Cross Roads, Oxfordshire, England; polished slab from a shallow-water reef (type VI reef) showing well developed, pronounced growth banding; axial growth rate approx. 2 mm/yr. Note the marked distinctness of the high- and low-density bands, and the low/high density band ratio (approx. 0.5); ×6.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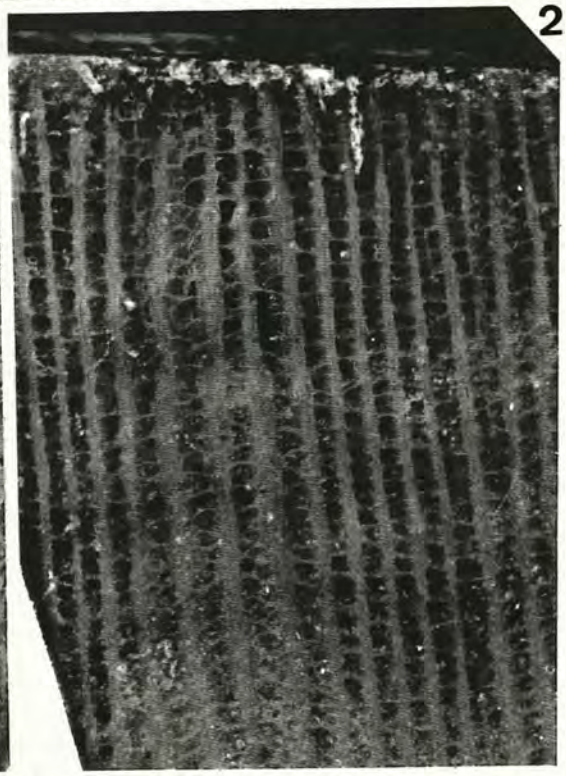
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Plate 8.2: Coral growth banding as seen in thin sections

Figures 1-2: *Thamnasteria concinna.* Coral Rag. Figure 1, Ayton Farm, Yorkshire, England; photomicrograph of unstained thin-section; × 7. Figure 2, Shellingford Cross-Roads, Oxfordshire, England; photomicrograph of stained thin-section; × 5.

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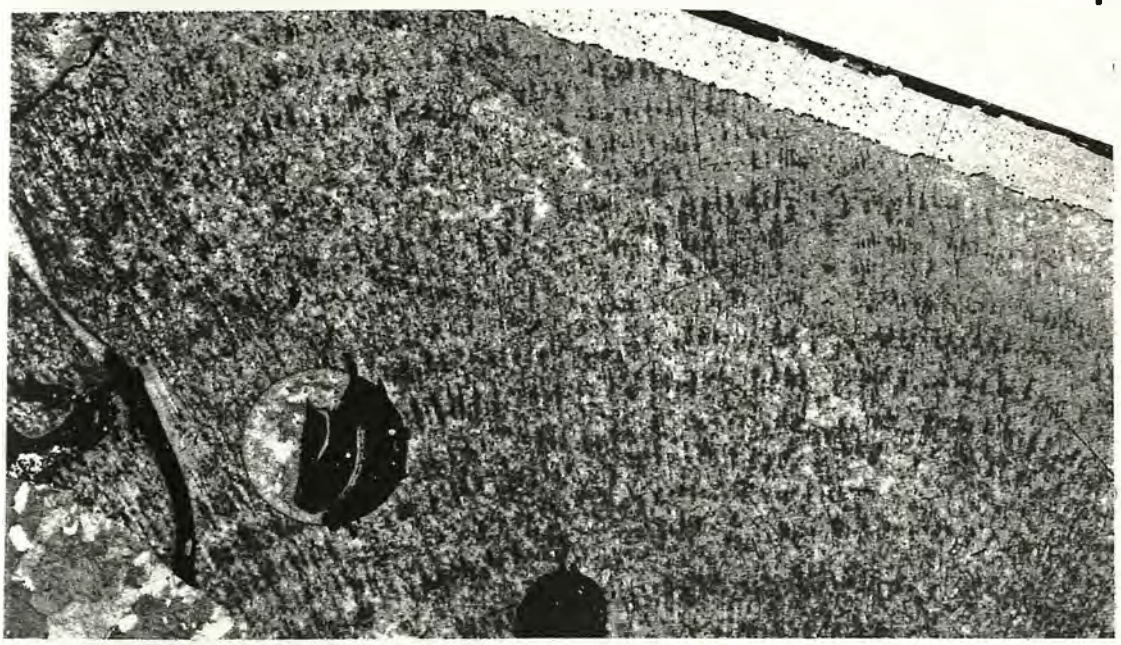


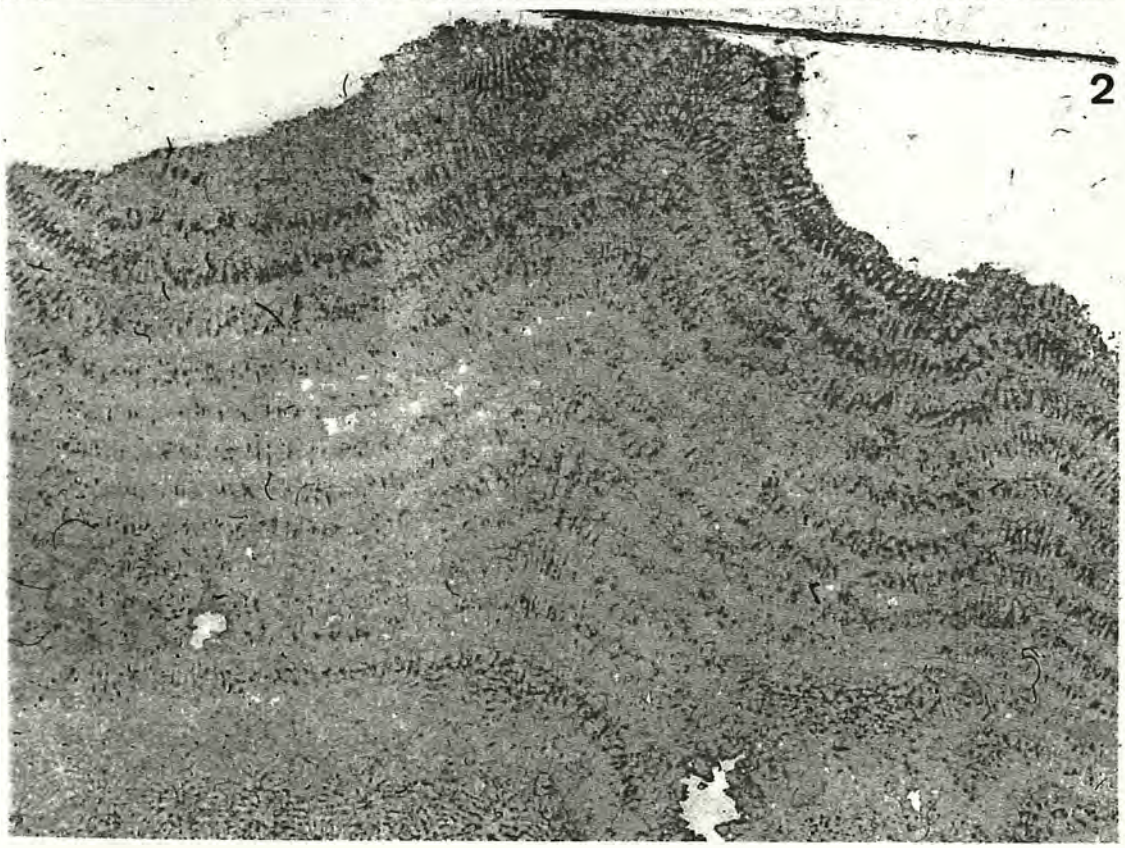
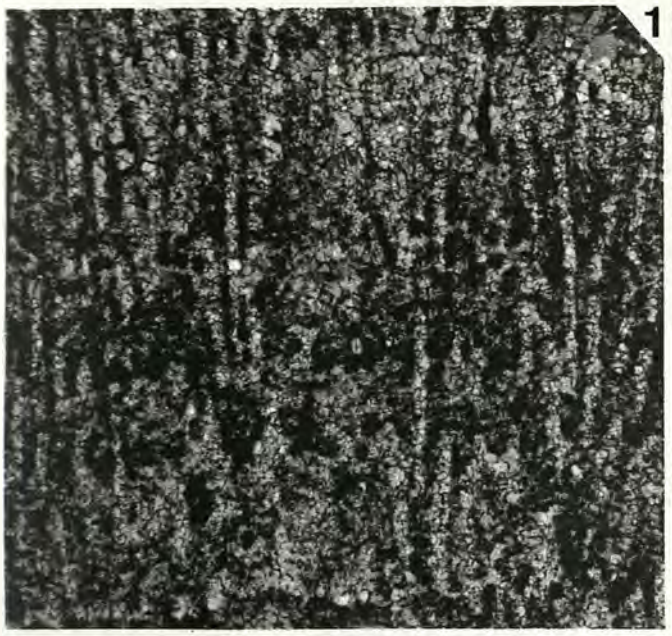


Plate 8.3: Details of coral growth bands and growth banding in branching ramose forms

Figures 1-3: *Thamnasteria concinna*. Lower reef complex, Châtel-Censoir, Burgundy, France; photomicrograph of unstained thin-section from a deep-water microsolenid biostrome (type I reef), showing thinning and thickening of skeletal relics and their neomorphic replacement by calcite (the light coloured coarsely crystalline material); low-density bands (dark zones) show the best preserved septa since they were originally thinner with fewer dissepiments resulting in less neomorphic replacement. Dark material between the septa is likely to represent early marine peloidal cements; Figure 1, × 15; figure 2, × 40; figure 3, × 85.

Figure 4. *Thamnasteria dendroidea*. Upper reef complex, Haudainville (type III-V reef), Lorraine, France; polished slab; axial growth rate approx. 13 mm/yr.; ×1.5.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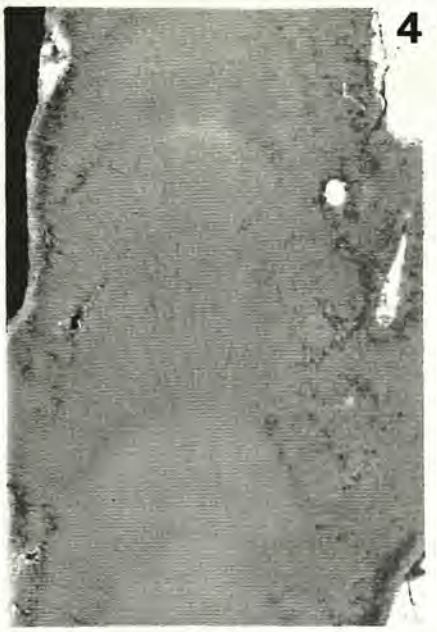
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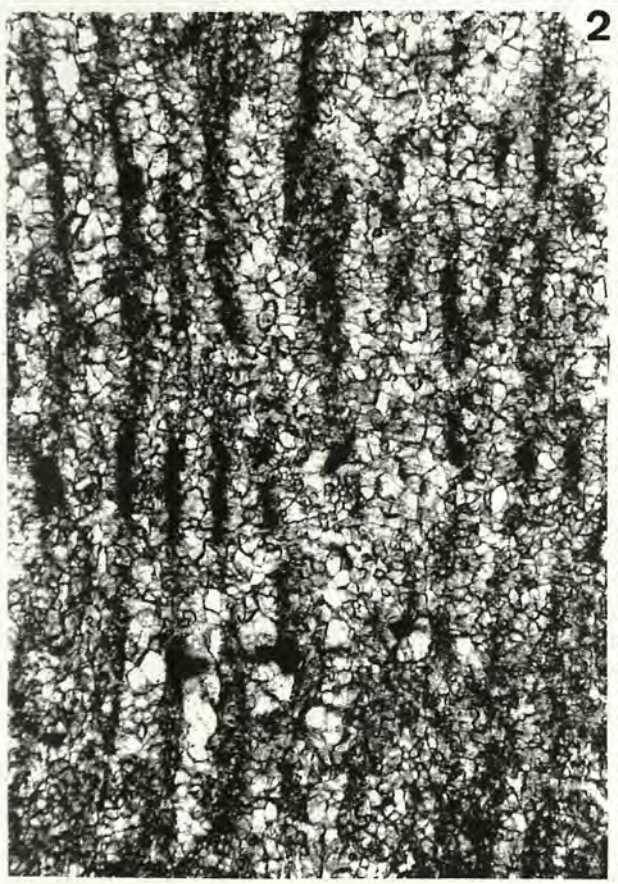
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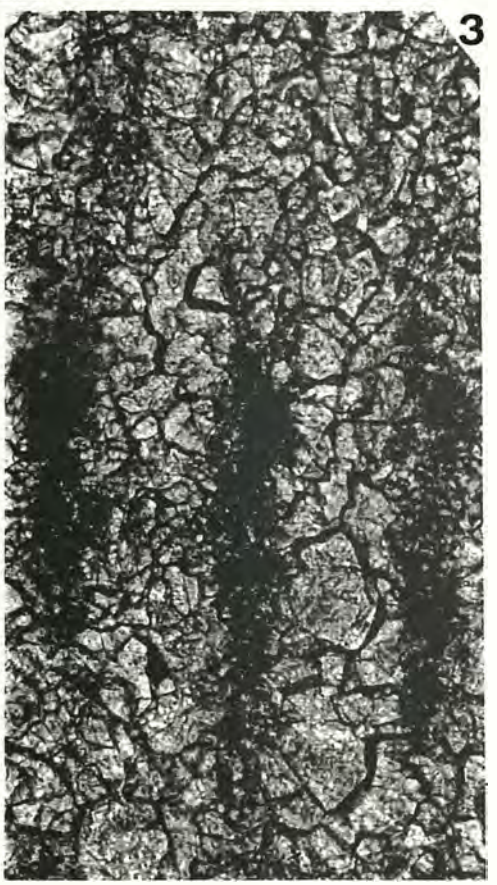
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Appendix 1: Summary tables

APPENDIX 1: SUMMARY SHEET

A1: EXPLANATION OF THE TERM USED IN THE SUMMARY SHEETS AND TEXT

REEF STRUCTURE AND FACIES

General

Unit name..... Formal lithostratigraphic name of the reef-bearing unit.

Stratigraphic age..... Age of reefal unit and ammonite zone and sub-zone where data available.

Dimensions and form

Reef form..... Form and geometry of reef as seen in cross section. Terms used: domal, lensoid, biostromal (sheet-like).

Vertical extent..... Cross-sectional thickness of reef as seen in outcrop. Where the full vertical extent of the of the reef is not visible minimum values are given.

Lateral extent..... Lateral dimensions of reef. Where the full lateral extent of the of the reef is not visible minimum values are given. Also indicated here is the framework continuity. Varies from "continuous" (reef framework laterally continuous; very few, if any lateral breaks by sediment-rich zones) to "discontinuous" (reef unit frequently broken by patches of bioclastic sediment). The whole of the reef-bearing facies (including bioclastic-rich, framework-poor zones) is referred to as the "reefal unit".

Max. syn-depositional relief..... Maximum syn-depositional relief of the reef where this can be deduced.

Internal architecture.... Internal surfaces such as erosive surfaces, depositional surfaces (bedding), and clinoforms. Where no internal architecture is visible the reef is referred to as massive.

Facies and sedimentology

Intra-reef sediment..... Description of the sediment occurring within the reef framework, in-between the framebuilders.

Inter-reef sediment..... Description of the sediment occurring either side of the reef and deposited contemporaneously with it.

Pre-reef unit..... Facies on which reef development occurs.

Post-reef unit..... Facies which overlies and/or onlaps the reef.

Sedimentary structures.... Description of sedimentary structures in the reefal facies (e.g. channeling, cross bedding, etc.).

Early cementation?..... Whether or not the reef had undergone early cementation as revealed by features such as hardgrounds, boring and syn-sedimentary reef-rock fragmentation.

Depositional environment

Position on platform.... Type of platform reef development had occurred on and the position of reef development in relation to the geometry of the platform.

Sedimentary regime... Summary of the depositional environment and sedimentary regime. In particular evaluation of palaeobathymetry, sedimentation rates and styles, and hydrodynamic energy levels.

PALAEOECOLOGY

Coral fauna

Number of genera..... Palaeoecological richness at generic level. The total number of coral genera identified solely by the author.

Dominance patterns..... A qualitative indication of the taxonomic diversity at generic level of the coral fauna. Where quantitative data is available Shannon Wiener (S-W) indexes have been calculated and are placed in brackets. Also indicated are the dominant and common coral taxa of the assemblage.

Dominant growth forms..... The growth forms and habits that dominate the reef fauna. (See below for definitions of terms used.)

General colony size..... The average colony size. Where more than one growth form is common, average colony size for each growth form is indicated.

Coral skeletal biovolume.... The proportion of in situ coral skeleton relative to the intra-reef sediments. Measured from longitudinal sections through reefal units.

Associated fauna

General development..... The "associated fauna" refers to all the fauna occurring within the reef excluding the corals. The "general development" of the associated fauna is a qualitative indication of the relative richness and abundance of the associated fauna relative to Late Jurassic reef faunas in general. Qualitatively indicated by terms such as "very highly developed" (many faunal groups represented and their abundant occurrence) to "very poorly developed" (few faunal groups represented, and those that are present have a very rare occurrence).

Main taxa..... The most obvious representatives of the associated fauna. Also indicated where possible is the life habit and ecological group of the taxa.

Extent of bioerosion..... A qualitative indication of the degree to which the reef framework has been bioeroded as inferred from the occurrence of trace fossils. Also indicated are the main bioeroders. Measured on a 5 point scale from "very high" (bioeroding ichnotaxa very common, some colonies completely destroyed) to "very low" (very few, if any, bioeroding ichnotaxa).

Algae

Type of algae..... Indication of the type of algae, if any, present within the reef.

Volume of algae..... Indication of the abundance of algae within the reef.

Role in reef-building..... Indication of whether the algae actively binds the reef framework.

Microbialite

Type of microbilite..... Indication of the type of microbialite, if any, present within the reef.

Volume of microbialite..... Indication of the abundance of microbialite within the reef.

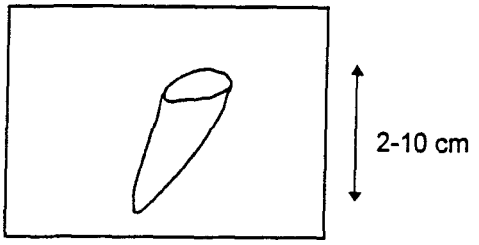
Role in reef-building..... Indication of whether the microbialite actively binds the reef framework.

Miscellaneous

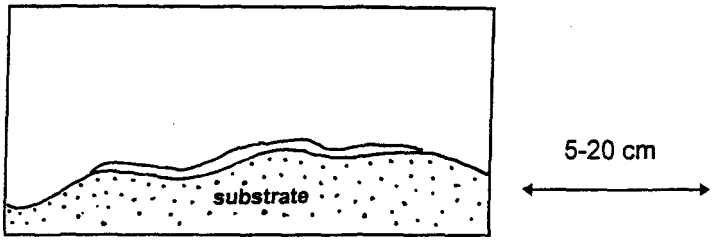
Zonation; succession..... Whether there is any evidence for ecological succession or zonation within a given reef framework. Also indicated here is any other miscellaneous information concerning reef development.

Coral growth forms.

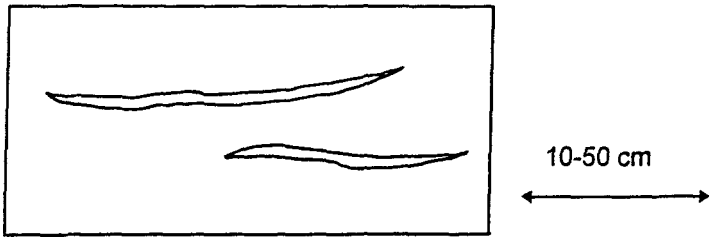
Solitary



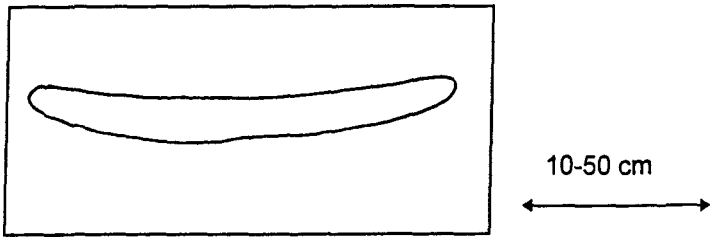
Encrusting



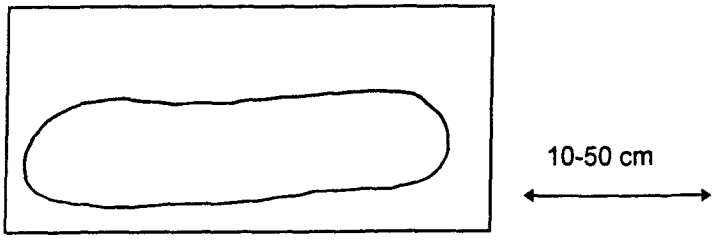
Lamellar and foliaceous



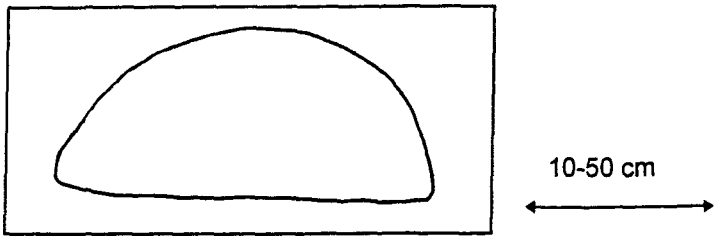
Platy



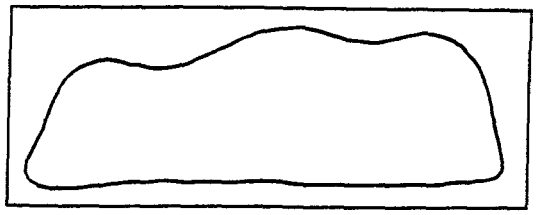
Tabular (sub-massive)



Domal

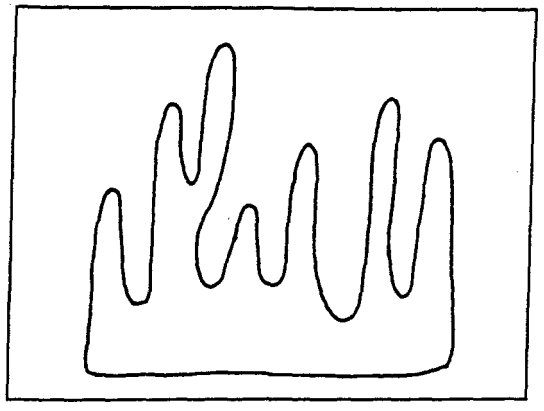


Massive
(irregular)



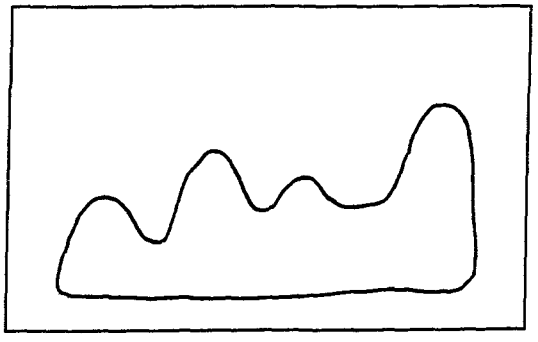
10-80 cm

Branching ramose



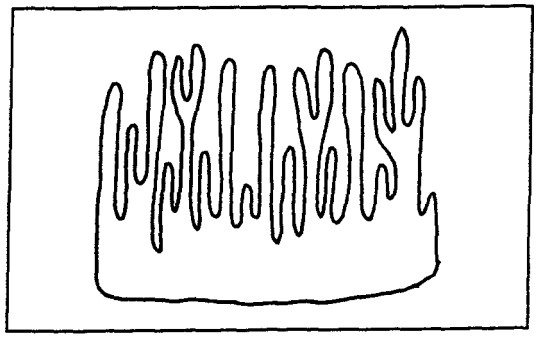
60-200 cm

Sub-branching ramose



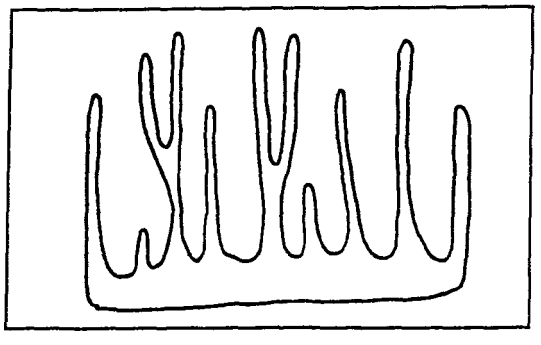
10-50 cm

Branching ramose
(dense or tight colony)



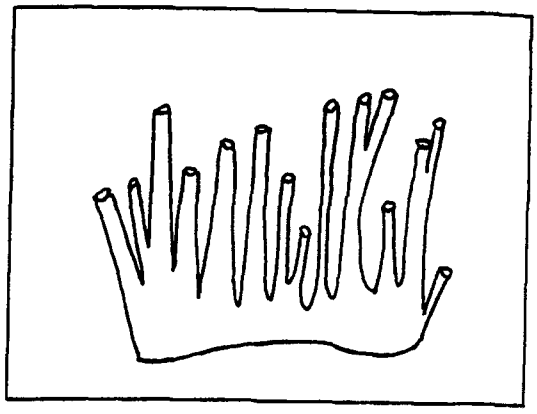
60-200 cm

Branching ramose
(loose or open colony)



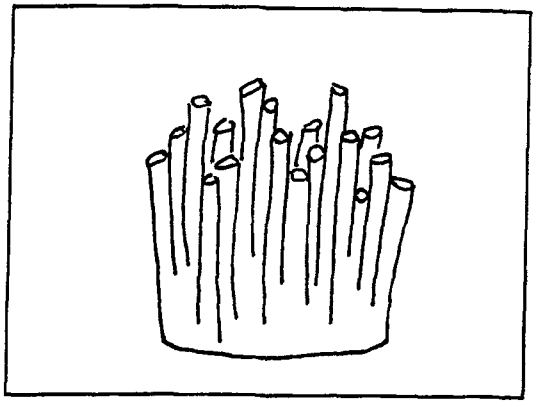
60-200 cm

Branching phaceloid



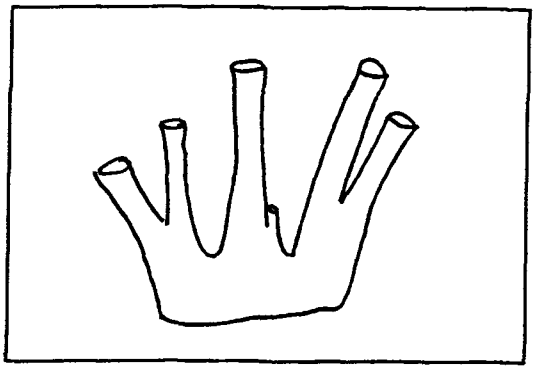
20-100 cm

Branching phaceloid
(dense or tight colony)



20-100 cm

Branching phaceloid
(loose or open colony)



20-100 cm

For more details of growth form and calicular integration terminology see:

Beauvais, L., Chaix, C., Lathuilière, B. & Löser, H., 1993. International working group on Scleractinian corals: report. *Fossil Cnidaria and Porifera Newsletter*, **22** (2), 45-69.

Wells, J. W., 1956. Scleractinia. In: Moore, R., *Treatise of invertebrate Palaeontology*, Part F., Coelenterates, F328-F444. Lawrence, Kansas.

CHÂTEL-CENSOIR, BURGUNGY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complexe récifal inférieur.**
Stratigraphic age	**M. Oxf. (*Transversarium* Zone).**
Dimensions and form	
Reef form	**Sheet-like; biostromal.**
Vertical extent	**15-20m.**
Lateral extent	**350m (min.); continuous.**
Max. syn-depositional relief	**Very little if at any.**
Internal architecture	**Well developed internal bedding surfaces.**
Facies and sedimentology	
Intra-reef Sediment	**Fine grained (0.1 mm) bioclastic packstones and wackestones; M/S/C: 80-60/ 0/40: biomicrites. Carbonate grains immature and mainly bioclasts of corals, echinoids and bivalves. Grain micritization is low and spongiostromate coatings are generally thin. Matrix mainly fine detrital material, lacks laminated peloidal fabrics.**
Inter-reef Sediment	**Not visible.**
Pre-reef unit	**Sponge- and ammonite-bearing micritic limestones.**
Post-reef unit	**Not visible.**
Sedimentary structures	**None evident.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform wide distribution of facies. Early in platform evolution; first reefal unit to develop.**
Sedimentary regime	**Relatively "deep-water" environment. Low energy levels: well below normal wave base. Light intensities extremely low. Sedimentation: mainly detrital (as opposed to peloidal).**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**14.**
Dominance patterns	**High-moderate: 2 genera constitute 69% of the total coral skeletal biovolume. (S-W: 2.48). Dominated by microsolenids, such as *Microsolena* and *Dimorpharaea*.**
Dominant growth form	**Almost exclusively platy and lamella forms (94% of total coral skeletal biovolume).**
General colony size	**1-3 cm thick, 10-20 cm across.**
Coral skeletal biovolume.	**Increases from 30% at base to 50-60 in the main body of the reef.**
Associated fauna	
General development	**Poor-moderate, bivalves and echinoids can be locally abundant.**
Main taxa	**Bivalves and echinoids.**
Extent of bioerosion	**High: *Lithophaga* common; *Entobia* also present.**
Algae	
Type	**Red algae absent.**
Volume of algae	**Insignificant.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**Thin (<3 mm) spongiostromate crusts present to the top surface of some plates.**
Volume	**Common on plates, though volumetrically insignificant.**
Role in reef-building	**Insignificant.**
Miscellaneous	
Zonation; succession	**Degree of framework development increases from base up.**

QUATRE PIEUX, BURGUNGY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complexe récifal supérieur.**
Stratigraphic age	**U. Oxf. (*Bimammatum* Zone).**
Dimensions and form	
Reef form	**Not visible.**
Vertical extent	**15m (min.).**
Lateral extent	**200m; continuous.**
Max. syn-depositional relief	**Probably, but difficult to quantify.**
Internal architecture	**None; massive.**
Facies and sedimentology	
Intra-reef sediment	**Hard dense creamy micrite. Mainly bioclastic and intraclastic packstones and grainstones; M/S/C: 50-0/10-50/40 (pelmicrites - pelsparites). Rapid variations in textural types. Matrix peloidal with abundant, well developed laminated fabrics. Carbonate grains very immature. Intraclasts abundant. Bioclasts almost totally composed of coral fragments.**
Inter-reef sediment	**Not visible.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Diceras beds followed by beach facies.**
Sedimentary structures	**Small scale scour structures; micro-spur and groove.**
Early cementation?	**Extremely early; possibly even syn-sedimentary.**
Depositional environment	
Position on platform	**Platform edge (by-pass margin); reef-front.**
Sedimentary regime	**High energy environment, rapid development of microbial cements. Intra-reef bioclastic sedimentation rates relatively low. Bioclastic material rapidly incorporated into reef framework. Efficient export of reef debris out of reef complex. Upper sub-tidal.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**21.**
Dominance patterns	**Moderate dominance: 5 genera approx. equally as abundant. *Meandrophyllia, Microsolena, Pseudocoenia* and the phaceloid amphiastrids such as *Mitrodendron* and *Donacosmilia* are common.**
Dominant growth form	**Massive predominate with phaceloids secondarily common. Branching ramose forms are conspicuous by there complete absence.**
General colony size	**Massive forms: 30 by 30 cm. Phaceloids: 1m high.**
Coral skeletal biovolume	**High - very high: 60-85%.**
Associated fauna	
General development	**Extremely poorly developed: species poor and low abundances.**
Main taxa	**Forams, bryozoans, algae, etc.**
Extent of bioerosion	**Low-very low: boring bivalves conspicuously absent.**
Algae	
Type	**Red algae**
Volume of algae	**Present though not common.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**(1) Massive, macroscopically structureless; microscopically laminated (fine agglutinated stromatolites). 2) Spongiostromate crusts (poorly developed); 3) ?porostromate crusts.**
Volume	**Massive; macroscopically structureless; microscopically laminated microbialite very abundant - dominates areas of the intra-reef sediment.**
Role in reef-building	**Fundamental: early cementation of microbialite bound the skeletal framework giving the reef structural rigidity.**
Miscellaneous	
Zonation; succession	**None visible.**

BOIS DU PARC, BURGUNGY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complexe récifal supérieur.**
Stratigraphic age	**U. Oxf. (*Bimammatum* Zone).**
Dimensions and form	
Reef form	**Not visible**
Vertical extent	**40m (min.).**
Lateral extent	**50m by 100m (min.), moderately continuous.**
Max. syn-depositional relief	**Probably: but difficult to quantify.**
Internal architecture	**None; massive.**
Facies / sedimentology	
Intra-reef sediment	**Hard dense creamy micrite. Mainly bioclastic packstones. M/S/C: 30-50/ 10-20/ 50-60: Microbial pelmicrites and biopelsparites. Peloidal lamellae common. Bioclasts very immature. Intraclasts abundant. Bioclastic material almost totally coral.**
Inter-reef sediment	**Not visible.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Not visible.**
Sedimentary structures	**Storm shell beds.**
Early cementation?	**Extremely early.**
Depositional environment	
Position on platform	**Proximal back-reef; behind outer reef complex.**
Sedimentary regime	**Calm back reef setting with low energy levels and low bioclastic sedimentation rates. Rapid cementation of microbialally mediated peloidal micrites. Upper sub-tidal.**

PALAEOECOLOGY

Reef Feature	
Coral fauna	
Number of genera	**21.**
Dominance patterns	**Moderate dominance: 5 genera approx. equally as abundant. Common taxa are: Branching ramose: *Pseudocoenia, Meandrophyllia*.. Massive: *Pseudocoenia, Stylina, Meandrophyllia, Isastraea* and *Cyathophora.* Branching phaceloid: *Dermoseris.***
Dominant growth form	**Massive and branching ramose.**
General colony size	**Branching ramose: 1m high. Massive: 20 by 10 cm.**
Coral skeletal biovolume	**Low to high 30-65%.**
Associated fauna	
General development	**Extremely poorly developed: species poor and low abundances.**
Main taxa	**Forams, red algae.**
Extent of bioerosion	**Moderate-high: primarily boring bivalves.**
Algae	
Type	**Red algae.**
Volume of algae	**Can be common.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**1) Massive, macroscopically structureless; microscopically laminated. 2) Spongiostromate crusts (poorly developed); 3) porostromate crusts (relatively common).**
Volume	**Massive; macroscopically structureless; microscopically laminated microbialite very abundant - dominates the intra-reef sediment.**
Role in reef-building	**Important: early cementation of microbialite bound the skeletal framework giving the reef structural rigidity.**
Miscellaneous	
Zonation; succession	**None visible.**

ROCHERS DU SAUSSOIS, BURGUNGY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complexe récifal supérieur.**
Stratigraphic age	**U. Oxf. (*Bimammatum* Zone).**
Dimensions and form	
Reef form	**Not visible.**
Vertical extent	**50m.**
Lateral extent	**400m, very discontinuous.**
Max. syn-depositional relief	***Probably: but difficult to quantify.***
Internal architecture	**Yes, internal planar bands of differing degrees of framework construction. ("Corrugated" structure).**
Facies and sedimentology	
Intra-reef sediment	**Coarse (1.5-3 mm) grained chalky bioclastic packstones. M/S/C: 25-35/25-35/30-50 (packed biomicrites-poorly washed biosparites). Lithoclastic material dominated over bioclastic material. Bioclastic material not dominated by coral material but bivalve and echinoid material also common. Carbonate grains generally texturally mature; posses spongiostromate coatings and well micritized. Laminated peloidal fabrics and rinds absent.**
Inter-reef sediment	**Coarse bioclastic packstones.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Not visible.**
Sedimentary structures	**Storm horizons common.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Distal back-reef. Lower part of an aggradational succession.**
Sedimentary regime	**Calm back reef setting. Energy levels low-moderate. High bioclastic production. The absence of sediment export mechanisms led to large accumulations of bioclastic material. Bathymetry: Just below normal wave base.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**22.**
Dominance patterns	**Difficult to qualify due to poor exposure.**
Dominant growth form	**?Massive.**
General colony size	
Coral skeletal biovolume	**Generally exceedingly low: 20%, though in zones of better framework construction can reach 60%, though this is only local.**
Associated fauna	
General development	
Main taxa	**Brachiopods, *Trichites*, nerineids, Oyster type bivalves (common); *Chlamys*; echinoids. Concentrated in framework poor, bioclastic rich zones.**
Extent of bioerosion	**Low. *Lithophaga*.**
Algae	
Type	***Red algae.***
Volume of algae	**Not common.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**Only as spongiostromate coatings and crusts on bioclasts; common.**
Volume	**Not abundant.**
Role in reef-building	**Insignificant.**
Miscellaneous	
Zonation; succession	**Top of the section capped with a high energy microfacies; increase in massive corals in the top 3m (especially of *Stylina*).**

ROCHE AUX POULETS, BURGUNGY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complexe récifal supérieur.**
Stratigraphic age	**U. Oxf. (*Bimammatum* Zone).**
Dimensions and form	
Reef form	**A series of tabular coral banks and small domal bioherms.**
Vertical extent	**Individual build-ups 18m across, 4-6m high (for domal build-ups), 100m across, 18m thick (for tabular build-ups).**
Lateral extent	**See above.**
Max. Syn-depositional relief	**Probably: but difficult to quantify.**
Internal architecture	**"Corrugated" structure present in areas.**
Facies and sedimentology	
Intra-reef sediment	**Fine grained (0.5-0.1 mm) bioclastic packstones and wackestones. M/S/C/: 65/5/35. Carbonate grains mainly immature bioclastic material. Bioclasts not dominated by coral material but bivalve and echinoid material also common. Lack spongiostromate crust and not highly micritized. Matrix: fine bioclastic, lithoclastic and peloidal material. No peloidal rinds or laminated fabrics.**
Inter-reef sediment	**Not visible.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Lagoonal and beach deposits.**
Sedimentary structures	**Storm beds.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Distal back-reef: Upper part of an aggradational succession.**
Sedimentary regime	**Back reef setting. Energy levels: moderate. Shallow-water: upper sub-tidal zone.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**22.**
Dominance patterns	**Difficult to say.**
Dominant growth form	**?massive.**
General colony size	**Massive colonies: 20 by 30 cm.** **Thick platy colonies: 10 by 30 cm.**
Coral skeletal biovolume	**Low: Less than 30%.**
Associated fauna	
General development	**Poor-Moderate.**
Main taxa	**Brachiopods, chaetetids, forams.**
Extent of bioerosion	**Low.**
Algae	
Type	**Red algae.**
Volume of algae	**Not common.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**Rare: occurring as thin spongiostromate coatings and crusts on bioclasts.**
Volume	**Not abundant.**
Role in reef-building	**Insignificant.**
Miscellaneous	
Zonation; succession	**None evident.**

FOUG; CORAL MARL; (FOUG 1), LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	*Complex récifale inférieure.*
Stratigraphic age	Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).
Dimensions and form	
Reef form	Sheet like; biostromal.
Vertical extent	approx. 3.5m.
Lateral extent	At least 400m at outcrop; probably platform wide.
Max. syn-depositional relief	*Very little if any.*
Internal architecture	Vague bedding.
Facies and sedimentology	
Intra-reef sediment	*Very muddy, dark gray/brown marls;* bioclastic packstones: M/S/C: 30/0/70 (biomicrites). Significant siliciclastic clay component. The carbonate grains very immature (modal grain size 0.5 mm). They are essentially all bioclasts with lithoclasts being very rare. The bioclasts mainly fragments of coral echinoid and bivalve. *There is very little micritization and spongiostromate crusts are generally absent.* The matrix is homogeneous, lacks laminated fabrics and made up of very fine detrital material and poorly defined peloids. Small (0.05 mm) pyrite fragments are present within the matrix.
Inter-reef sediment	Not visible.
Pre-reef unit	*Terraine á Chailles* (relatively deep-water marls). Boundary marked by oyster hardground.
Post-reef unit	Coral limestone (see next summary sheet)
Sedimentary structures	None evident.
Early cementation?	No.
Depositional environment	
Position on platform	Platform wide; developed early in the evolution of the platform.
Sedimentary regime	Calm water; well below normal wave base. *Significant siliciclastic influx.*

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	11.
Dominance patterns	High; *Dimorpharaea* constitutes over 50% of the total coral skeletal biovolume.
Dominant growth forms	Platy-tabular.
General colony size	20-30 cm across, 1-4 cm thick.
Coral skeletal biovolume	Very high; 60-80%.
Associated fauna	
General development	Very well developed.
Main taxa	Bivalves: *Nanogyra, Chlamys, Camptonectes, Ctenostreon, Plagiostoma* and *Pterocardia.* Echinoids: *Glypticus, Paracidaris, Hemicidaris, Rhabdocidaris, Pseudodiadema* and *Stomechimus.* Other groups present: Crinoid (*Apinocrinus*), terebratulids, siliceous and calcareous sponges and crustaceans. There is also a well developed cryptic fauna essentially of serpulids, thecidean brachiopods and rare bryozoans.
Extent of bioerosion	The boring intensity is high and mainly attributed to boring bivalves; *Entobia* borings present.
Algae	
Type	Red algae absent.
Volume of algae	———
Role in reef-building	———
Microbialite	
Type	Only as thin spongiostromate crusts on some of the coral plates.
Volume	*Insignificant.*
Role in reef-building	Insignificant.
Miscellaneous	
Zonation; succession	None evident.

FOUG; CORAL LIMESTONE; (FOUG 2), LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	Complex récifale inférieure.
Stratigraphic age	Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).
Dimensions and form	
Reef form	Either as small mounds (1-3m high; 5m across) or larger structure many meters across and high.
Vertical extent	(See above).
Lateral extent	400m though very discontinuous.
Max. syn-depositional relief	Less than 2m .
Internal architecture	Sheet-like; bedded.
Facies and sedimentology	
Intra-reef sediment	At outcrop the coral limestone is sedimentologically very distinct from the underlying coral marl. It is a white (a result of the marked decrease in its siliciclastic component), hard and resistant bioclastic packstone. However the microfacies is virtually identical to that of the coral marl, except for the absence of siliciclastics.
Inter-reef sediment	Coarse bioclastic packstones.
Pre-reef unit	Coral Marl.
Post-reef unit	Oncoidal limestone; boundary marked by hardground.
Sedimentary structures	None evident.
Early cementation?	No.
Depositional environment	
Position on platform	Platform wide; developed early in the evolution of the platform.
Sedimentary regime	Calm water; well below normal wave base. The cessation of muddy siliciclastic influx at the top of the coral marl marks the beginning of the coral limestone which developed in a relatively siliciclastic free sedimentary regime.

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	13.
Dominance patterns	High; *Microsolena* constitutes over 50% of the total coral skeletal biovolume.
Dominant growth forms	Platy-tabular.
General colony size	30-50 cm across, 2-5 cm thick.
Coral skeletal biovolume	High; 50% (within individual build-ups).
Associated fauna	
General development	Well developed. Essentially as coral marl though groups not so abundant.
Main taxa	As coral marl; *Trichites* appears.
Extent of bioerosion	As coral marl, though slightly less abundant
Algae	
Type	Red algae absent.
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	Only as thin spongiostromate crusts on some of the coral plates.
Volume	Insignificant.
Role in reef-building	None.
Miscellaneous	
Zonation; succession	None evident.

PAGNY-SUR-MEUSE, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	Complex Récifale Supérieure.
Stratigraphic age	Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).
Dimensions and form	
Reef form	Not attainable from outcrop.
Vertical extent	5-11m.
Lateral extent	Individual thickets approximately 5m across; discontinuous frameworks up to 20 m across.
Max. syn-depositional relief	Very slight.
Internal architecture	Vague 1-2m bedding.
Facies and sedimentology	
Intra-reef sediment	Not well exposed.
Inter-reef sediment	Fine-grained white chalky wackestone-mudstones. Microfacies: micrite dominated fabric with M/S/C ratios of 70/5/15; pelmicritic to pelbiomicritic. The carbonate grains are fine grained (average less than 0.3 mm), very immature and dominantly bioclasts. Micritization and spongiostromate crusts are not developed. The matrix is composed mainly of very fine detrital material and peloids. The fabric of the matrix is rather loose with frequent open spaces (?fenestrae), which are often infilled with fine peloids. The peloid are mainly lithoclasts and fragments of micritized grains. The fabric is blotchy possibly a result of bioturbation. No clear laminated peloidal fabrics are seen though some vague peloidal rinds are present. Spongiostromate peloidal crusts are well developed on branching phaceloid corals.
Pre-reef unit	Not seen.
Post-reef unit	Not seen.
Sedimentary structures	Storm shell lenses.
Early cementation?	No.
Depositional environment	
Position on platform	Platform interior.
Sedimentary regime	Comparatively shallow water, quite water environment; very high mud sedimentation rate and hence turbid environment.

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	13.
Dominance patterns	High; *Aplosmilia* constitutes nearly 80% of the total coral skeletal biovolume.
Dominant growth forms	*Dominated by phaceloid branching forms.* Occasional large massive colonies.
General colony size	Individual phaceloid colonies up to 3 m across 5 m high.
Coral skeletal biovolume	Generally low (less than 20%), though within individual thickets it can be up to 60%.
Associated fauna	
General development	Poorly developed.
Main taxa	Red algae can be common; small encrusters on phaceloid branches (serpulids, bryozoans, etc.)
Extent of bioerosion	Low-moderate; *Entobia*, boring forams and bivalves.
Algae	
Type	Red algae common.
Volume of algae	individual colonies common though volumetrically insignificant.
Role in reef-building	Insignificant.
Microbialite	
Type	Spongiosromate crusts around phaceloid branches.
Volume	Common around branches but volumetrically insignificant.
Role in reef-building	Insignificant.
Miscellaneous	
Zonation; succession	None evident.

LÉROUVILLE; REEF 1; LOWER REEF COMPLEX, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complex récifale inférieure.**
Stratigraphic age	**Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).**
Dimensions and form	
Reef form	**Domal.**
Vertical extent	**At least 20m at its thickest.**
Lateral extent	**At least 200m.**
Max. syn-depositional relief	**Approximately 20m, though this may be antecedent.**
Internal architecture	**No cross-section available for study.**
Facies and sedimentology	
Intra-reef sediment	**The intra-reef sediments are coarse-grained bioclastic packstone; M/S/C: 40-50/0/50-60 (biomicrites). The carbonate grains are all bioclasts. Coarse (0.5 mm), angular bioclasts predominate, very poorly sorted. There is no grain micritization or spongiostromate crust development. Compositionally the bioclasts are mainly of coral, echinoid and bivalve. The matrix is generally homogenous and composed of tightly packed peloids. Peloidal laminations and rinds are absent, though in areas vague peloidal laminations are present.**
Inter-reef sediment	**Not seen.**
Pre-reef unit	**Not seen. (?Terraine á Chailles)**
Post-reef unit	**Crinoidal grainstone.**
Sedimentary structures	**Top surface of the reef has developed a hardground and onlapped by ripples bioclastic sands.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior.**
Sedimentary regime	**The depositional environment probably changed from quite, moderate energy (below normal wave base) early in the development of the reef to high energy (above normal wave base) at the top of the reef before it was drowned by crinoidal grainstones. Hardground on the top surface of the reef signifies low background sedimentation rates. Bioclastic material was transported down the reef slopes as sediment slumps and tongues. No siliciclastic influx.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**11.**
Dominance patterns	**Difficult to say.**
Dominant growth forms	**Platy.**
General colony size	**2 cm thick; 20 cm across.**
Coral skeletal biovolume	**No exposure to estimate this.**
Associated fauna	
General development	**Poor outcrop surface makes data collection difficult. Associated fauna is generally moderately well developed.**
Main taxa	***Paracidaris florigemma* spines and encrusting bivalves are common. Also present: serpulids, forams, sponge spicules, bryozoan and gastropods.**
Extent of bioerosion	**Bioerotional activity is moderate and solely by boring bivalves. Bioerotion is especially evident on the top surface of the reef and local hardgrounds.**
Algae	
Type	**None.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**Only as spongiostromate coatings.**
Volume	**Rare.**
Role in reef-building	**None.**
Miscellaneous	
Zonation; succession	**Slightly higher energy microfacies at the top of the reef.**

LÉROUVILLE; REEF 2; *MEANDARAEA* BIOFACIES, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complex récifale inférieure.**
Stratigraphic age	**Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).**
Dimensions and form	
Reef form	**Biostromal.**
Vertical extent	**2m.**
Lateral extent	**350m.**
Max. syn-depositional relief	**None.**
Internal architecture	**Wavy internal bedding.**
Facies and sedimentology	
Intra-reef sediment	**Fine chalky bioclastic wackestone. M/S/C ratios: 80-90/5/10-20 (biopelmicrite). The carbonate grains are almost totally composed of bioclasts. They are fine grained (average: 0.1 mm; 90% of the grains less than 0.5 mm) angular and poorly sorted. The bioclasts are mainly of coral, though echinoid and bivalve material is also common. Large (0.6 mm) peloidal intraclasts are present. The bioclasts lack spongiostromate coatings and are not micritized. The matrix is mainly of precipitated peloids, the rest is made up of fine detrital material. Graded peloidal fabrics are present, especially under the coral plates.**
Inter-reef sediment	**Not seen.**
Pre-reef unit	**Crinoidal grainstone.**
Post-reef unit	**Bioclastic packstones.**
Sedimentary structures	**Local rudstones beds tens of cm thick are present suggesting storm events.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior.**
Sedimentary regime (including reef 3)	**Reefs 2 and 3 developed in very shallow water on top of the antecedent topography created by a relatively thick unit of crinoidal sandwaves. Reef development was preferentially within the protected quiet water areas below the crests of the sandwaves, allowing packstone sediments to develop in and around the reefs. Bioclastic sedimentation rates appear to have been low. Inter-reef grainstones of reef 3 suggest that energy levels of this reef may have relatively high, perhaps developing in a more exposed location. This also resulted in a high bioclastic sedimentation rate.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**10**
Dominance patterns	**High; *Meandaraea* completely dominates the fauna.**
Dominant growth forms	**Platy.**
General colony size	**1 cm thick; 25 cm across.**
Coral skeletal biovolume	
Associated fauna	
General development	**Poor.**
Main taxa	***Cidaris* spines, *Chlamys*, *Lima* and large terebratulids brachiopods are common. Organisms under-encrusting the coral plates include serpulid, bivalves and ?bryozoans.**
Extent of bioerosion	**Not conspicuous.**
Algae	
Type	**None.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**None.**
Volume	_____
Role in reef-building	_____
Miscellaneous	
Zonation; succession	**None evident.**

LÉROUVILLE; REEF 3; *ISASTRAEA* BIOFACIES, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complex récifale inférieure.**
Stratigraphic age	**Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).**
Dimensions and form	
Reef form	**Biostromal.**
Vertical extent	**3-4 m thick.**
Lateral extent	**At least 300 m.**
Max. syn-depositional relief	**None.**
Internal architecture	**Vague bedding due to the platy nature of the framebuilders.**
Facies and sedimentology	
Intra-reef sediment	**Bioclastic packstones; M/S/C: 60-70/0/30-40 (biomicrites). The carbonate grains are composed solely of bioclasts of which corals (90%). The bioclasts are coarse-grained (0.5-2 mm), angular and poorly sorted. They lack spongiostromate crusts and are not micritized. The matrix is homogenous, with no obvious peloidal fabrics. The matrix is primarily composed of fine compacted peloidal material.**
Inter-reef sediment	**?Bioclastic grainstones.**
Pre-reef unit	**Bioclastic packstones.**
Post-reef unit	**?Bioclastic grainstones.**
Sedimentary structures	**None seen.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior**
Sedimentary regime	**(See Lérouville reef 2 summary sheet).**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**8.**
Dominance patterns	**Very high; *Isatraea* overwhelmingly dominates (80%).**
Dominant growth forms	**Thick platy and tabular forms.**
General colony size	**Large; 8-20 cm thick; 50-100 cm across.**
Coral skeletal biovolume	**Very high; >60%.**
Associated fauna	
General development	**Poor.**
Main taxa	***Chlamys*.**
Extent of bioerosion	**Moderate; boring bivalves.**
Algae	
Type	**None.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**None.**
Volume	_____
Role in reef-building	_____
Miscellaneous	
Zonation; succession	**None evident.**

ST. MIHIEL, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	***Complex Récifale Supérieure***
Stratigraphic age	**Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).**
Dimensions and form	
Reef form	**Form of reefal unit not visible. Individual framestones within the reefal unit have a rather planar tabular geometry.**
Vertical extent	**At least 40 m; individual framestones: 10 m (max.), 2-3 m (av.)**
Lateral extent	**Discontinuous at least 300 m; individual framestones: 20 m**
Max. syn-depositional relief	
Internal architecture	**"Corrugated" structure (as in the Saussois reef, Burgundy).**
Facies and sedimentology	
Intra-reef sediment	**Bioclastic packstones; biomicrites; bioclasts coarse, sub-angular to sub-rounded, mod. well sorted. Micritization and crust formation of bioclasts poorly developed. Matrix completely micritic (spar <3%) composed of both detrital and peloidal material. Peloidal rinds and laminations absent.**
Inter-reef sediment	**Chalky bioclastic packstones.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Not visible.**
Sedimentary structures	**Well developed storm horizons.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior, well behind platform edge.**
Sedimentary regime	**Calm back reef setting. Energy levels low-moderate. High bioclastic production. The absence of sediment export mechanisms led to large accumulations of bioclastic material. Bathymetry: Just below normal wave base. (See Saussois reef, Burgundy; chapter 2, section 2.5.).**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**17.**
Dominance patterns	**Moderate**; no one genera dominates. ***Thamnasteria, Stylina, Isastraea, Meandararaea*** and ***Meandrophyllia*** common.
Dominant growth forms	**Branching ramose and massive forms**
General colony size	**Branching ramose: up to 1m high and across.** **Massive forms: generally around 40 cm across and 30 cm thick.**
Coral skeletal biovolume	**Generally low (<20%); locally quite high (>60%).**
Associated fauna	
General development	**Extremely poorly developed.**
Main taxa	***Chlamys***
Extent of bioerosion	**Low-moderate; boring bivalves.**
Algae	
Type	**None seen.**
Volume of algae	———
Role in reef-building	———
Microbialite	
Type	**Only as thin spongiostromate coatings.**
Volume	**Insignificant.**
Role in reef-building	**None.**
Miscellaneous	
Zonation; succession	**Top of the section capped with a high energy microfacies; increase in massive corals in the top 3m (especially of *Stylina*).**

HAUDAINVILLE, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Complex Récifale Supérieure**
Stratigraphic age	**Formation Récifale de Lorraine (undifferentiated): Middle Oxfordian (top of *Plicatilis* Zone base of *Bifurcatus* zone).**
Dimensions and form	
Reef form	**Individual build-ups domal up to 8 m high and 20 m across.**
Vertical extent	**15 m.**
Lateral extent	**At least 300 by 300 by 15 m; discontinuous**
Max. syn-depositional relief	**A few metres.**
Internal architecture	**None evident.**
Facies and sedimentology	
Intra-reef sediment	**Chalky bioclastic packstones/wackestones; M/S/C: 30-50/5-10/45-65 (biomicrites). Bimodal grain-size distribution (Av. sizes: 1-2 mm and 0.1-0.5 mm). Carbonate grains: mod.-well; rounded; high sphericity. Bioclasts dominate over lithoclasts (70/30%). Bioclasts mainly echinoids, corals and bivalves. Grain micritization is generally low. Spongiostromate coatings are not well developed. Grain orientation is absent. The matrix: extremely fine grained detritus (70%) and peloids (30%). Peloidal laminations and rinds rare and the matrix is generally homogeneous. Locally there are areas of bioclastic packstone; M/S/C: 50/0/50 (biomicrite); Saussois-type microfacies. The matrix is homogenous and peloidal laminations or rinds are generally absent, except under coral plates.**
Inter-reef sediment	
Pre-reef unit	**Crinoidal grainstones (sandwaves).**
Post-reef unit	**Onlapping bioclastic packstones-?grainstones.**
Sedimentary structures	**Very frequent storm erosive surfaces; often truncated coral colonies.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior.**
Sedimentary regime	**Quite, protected, shallow water environment. The reefs were prone to frequent storm events.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**18.**
Dominance patterns	**Moderate; *Thamnasteria dendroidea* dominates large areas of the framework. Also common: *Aplosmilia*, *Isastraea*, *Fungiastraea*, *Actinastraea*, *Calamophylliopsis*, *Dendraraea*, *Meandraraea* and *Microsolena*.**
Dominant growth forms*	**Brr. and delicate foliaceous forms dominate . Also common : Brp. and massive forms.**
General colony size*	**Brr.: metres high and across. Brp.: 1-2 m high colonies. Delicate foliaceous: individual plates thin (<1 cm); colonies up to 1m across and 50 cm tall. Massive forms: 20-40 cm across and 5-15 cm thick.**
Coral skeletal biovolume	**20-50% within individual build-ups.**
Associated fauna	
General development	**Moderate.**
Main taxa	***Solenopora*, *Chlamys*, echinoderms.**
Extent of bioerosion	**Low; boring bivalves.**
Algae	
Type	**Red algae.**
Volume of algae	**Common, though volumetrically insignificant.**
Role in reef-building	**None.**
Microbialite	
Type	**Only as spongiostromate coatings and crusts.**
Volume	**Present though not particularly common.**
Role in reef-building	**None.**
Miscellaneous	
Zonation; succession	**The initial colonizers of the bioclastics were domal forms; the other growth forms appear later.**
	(abbreviations above: Brr.: Branching ramose; Brp: branching phaceloid).

DOMPCERVIN, LORRAINE, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Oolith de St. Mihiel. (Post upper reef complex units).**
Stratigraphic age	**Lower Upper Oxfordian (lower *Bifurcatus* Zone).**
Dimensions and form	
Reef form	**No reefs. A series of stacked channels many of which are rich in coral material, intercalated with carbonate sand sheets and waves.**
Vertical extent (of channel)	**Channels 0.5-3m thick (at the center of the channel).**
Lateral extent (of channel)	**5-30m; more commonly of the larger size.**
Max. syn-depositional relief	———
Internal architecture	**None evident.**
Facies and sedimentology	
Intra-channel sediment	**The reefal debris concentrated in the central part of the channels: chalky coarse-grained bioclastic-peloidal packstones; biopelmicrite-biointrapelmicrite; M/S/C ratios of 60-40/10/30-50. Carbonate grains: poorly sorted (< 0.3 mm to boulder size). The carbonate grains include both bioclasts and peloidal fragments (50/50%). Peloids: lithoclasts, fragmented micritized grains, amorphous oncoids, and micritized ooids. Bioclasts: red algae and calcified cyanobacteria (10%), forams, corals (50%), bivalves (20%), echinoids(20%), brachiopods, and serpulids. Grain micritization high and spongiostromate crusts are common. Matrix: dominated by fine detrital material, especially of peloids (micritized bioclasts), lithoclasts and very fine micritized ooids. The is no grain orientation. There are local areas of sparite dominated textures with floating bioclasts. The intra-channel sediments grade both vertically and laterally to very fine grained (0.1 mm) well sorted pelsparites with very little if any large biogenic material.**
Inter-channel sediment	**More channels deposits and carbonate sand bodies.**
Pre-channel unit	**?Reefal units of the upper reef complex (though the contact is not seen)**
Post-channel unit	**The series of stacked channels are followed by sublithographic limestones.**
Sedimentary structures	**None other than those associated with the channels.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Platform interior.**
Sedimentary regime	**Mobile sandbodies and channels dominated the environments and precluded coral reef development. An *environment where constant currents* existed (winnowing out the muds), but were not very high energy. Abundant channels cut across the environment and brought in reefal debris from near-by in-situ reefs. The only in-situ biogenic development was of red algae/*Stylosmilia* meadows which developed in calm water protected environments.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**At least 16.**
Dominance patterns	**Difficult to say.**
Dominant growth forms	**Plocoid and meandroid colonies abundant.**
General colony size	**Domal forms 25-30 cm across.**
Coral skeletal biovolume	**Some channels up to 50%, though none in situ.**
Associated fauna	
General development	***Rich associated fauna though not generally in-situ.***
Main taxa	**Nerineids, diceratids and red algae.**
Extent of bioerosion	**some coral colonies can be highly bored.**
Algae	
Type	**Reds present**
Volume of algae	**common**
Role in reef-building	**Near the top of the section can form in-situ red algae/*Stylosmilia* meadows.**
Microbialite	
Type	**Only as porostromate and spongiostromate coatings.**
Volume	**Common.**
Role in reef-building	**No in-situ reefs seen.**
Miscellaneous	
Zonation; succession	———

L'ÉPINE; QUARRY 3; IN-SITU REEF FACIES, ARDENNES FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	?Formation Récifale de Lorraine.
Stratigraphic age	Middle Oxfordian (*Plicatilis* Zone).
Dimensions and form	
Reef form	Domal.
Vertical extent	11m.
Lateral extent	20m.
Max. syn-depositional relief	?5-8m.
Internal architecture	None; massive. However small (1m across) reef palaeocaves are frequent.
facies and sedimentology	
Intra-reef sediment	Dense, white microbial pelmicrites.
Inter-reef sediment	Peloidal grainstone sandwaves and reef rubble debris sheets.
Pre-reef unit	(As above).
Post-reef unit	(As above).
Sedimentary structures	None.
Early cementation?	Yes; very early; fundamental to reef building.
Depositional environment	
Position on platform	Distally steepened carbonate ramp; Platform interior.
Sedimentary regime	The facies were deposited on a clean carbonate platform with no siliciclastic influx. The carbonate sands represent active, constantly shifting sub-tidal shoals. During periods of inactivity the sand shoals were further stabilized by microbial mats and colonized by reef organisms. Reef development occurred on these stabilized sediments and in quiet areas protected by shoals. Tidal and storm blow-outs channels were abundant and shifted across the depositional environment. Debris sheets rich in reefal material were deposited following storm erosion and surf disintegration of the reefs in the more exposed areas. Currents and wave action was generally strong, and sufficient to drive sandwave migration, develop tidal channels and prevent deposition of mud and silt. Water depths were shallow sub-tidal, no more than few a meters.

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	24.
Dominance patterns	Moderate-high; 3 branching ramose genera tend to dominate (*Thamnasteria dendroidea* (type A), *Allocoenia* sp., *Dendrohelia coalescens*).
Dominant growth forms	Loose branching ramose forms.
General colony size	Branching colonies up to 1.5m high.
Coral skeletal biovolume	Very low, 10-15%.
Associated fauna	
General development	Moderate to well developed; very well developed in the reef rubble facies.
Main taxa	Bivalves: aracae, mytilacea, limacea, ostreacea. Gastropods: pleurotomariacea, trochacea Echinoderms: cidaroida, pedinoida. Reef-rubble facies has a very diverse bivalve and gastropod fauna including numerous nerineids.
Extent of bioerosion	High. Diverse boring ichnotaxa. *Talpina, Entobia, Trypanites* and *Gastrochaenolites* common.
Algae	
Type	Red (though as yet not unequivocally found in-situ in reefs)
Volume of algae	Not common.
Role in reef-building	None.
Microbialite	
Type	Massive dense macroscopically clotted microbialites; pseudostalactite and pillow forms.
Volume	Massive amount; dominate the inter-reef sediments.
Role in reef-building	Essential for reefs structural rigidity.
Miscellaneous	
Zonation; succession	None evident.

BELLÊME S/S APAINEI; IN-SITU REEF FACIES, NORMANDY, FRANCE

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**"Oolithe de Mortagne et de Bellême".**
Stratigraphic age	**Middle Oxfordian (*Plicatilis - Cautisnigrae* zone).**
Dimensions and form	
Reef form	**Lensoid.**
Vertical extent	**Max. 2m.**
Lateral extent	**40m (discontinuous).**
Max. syn-depositional relief	**?Max. 1m.**
Internal architecture	**Erosive surfaces.**
facies and sedimentology	
Intra-reef sediment	**Bioclastic mudstone to wackestone with small areas of grainstone; M/S/C ratios are approximately 40-60/0-10/30-50; biomicrites. Oncoids are completely absence and the allochems are dominated by small (0.005 mm), angular and moderately well sorted bioclasts, mainly of coral. The matrix is almost totally composed of a dense peloidal micrite which lacks clear laminations though in areas vague peloidal rinds are present. Peloidal fabrics can be abundant around coral branches. Bioclasts and biomorphs possess spongiostromate crusts and coatings.**
Inter-reef sediment	**Oncolitic and oolitic grainstones; biogenic debris deposits.**
Pre-reef unit	**(As above).**
Post-reef unit	**(As above).**
Sedimentary structures	**Erosive surfaces and channeling. Pre- and intra-reef sediments locally cross bedded.**
Early cementation?	**No.**
Depositional environment	
Position on platform	**Distally steepened carbonate ramp; Platform interior.**
Sedimentary regime	**Reefal thickets developed on a clean carbonate platform in the upper sub-tidal zone. Currents and wave action generally sufficient to prevent deposition of mud and silt particles, produce in winnowed, clean oncolitic and oolitic inter-reef sediments. These sediments were deposited as sand shoals and sheets in the more exposed, agitated areas of the platform and quite oncoidal flats behind inactive oolite\oncolite shoals. Coral patches and thickets developed in the more protected quieter waters around the shoals, where the sediments were more stable and where background sedimentation was lower. Episodic storms produces reef debris beds deposited in storm blow-out channels and erosive surfaces.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**15.**
Dominance patterns	**Dominated by branching ramose forms of *Thamnasteria* (type A) and *Stylina*.**
Dominant growth forms	**Loose branching ramose and to a lesser extent massive domal forms.**
General colony size	**Branching ramose: up to 1m; massive stylinids: 50 cm.**
Coral skeletal biovolume	**30%.**
Associated fauna	
General development	**High. Very well developed in the inter-reef sediments.**
Main taxa	**Byssate attached forms: arcids and mytilids (*Arca, Barbatia, Modiolus, Opis*); free living and fissure dwelling forms (*Chlamys*). Red algae; calcified cyanobacteria; small terebratulids; foraminifera. In inter-reef sediments: Gastropods: *Bourguetia, Nerinea, Turbo* and *Trochotomata; Diceras* is exceedingly common occurring in rich concentrations in inter-reef channel deposits.**
Extent of bioerosion	**Very high, mainly boring bivalves, though boring sponges also present.**
Algae	
Type	**Red (Solenporacea).**
Volume of algae	**Common - very common, with large colonies (up to 30 cm across).**
Role in reef-building	**insignificant, occasionally only on a local scale.**
Microbialite	
Type	**Spongiostomate crusts around some corals.**
Volume	**Abundant on some colonies.**
Role in reef-building	**Negligible, perhaps on a very local scale.**
Miscellaneous	
Zonation; succession	**None evident.**

LIESBERG, SWISS JURA

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Liesberg Member.**
Stratigraphic age	**Middle Oxfordian: *Transversarium* Zone, *Antecedens* Sub-zone.**
Dimensions and form	
Reef form	**Sheet-like; biostromal; bedded on a 1-3m scale.**
Vertical extent	**22m.**
Lateral extent	**At outcrop studied 170m, though platform wide distribution.**
Max. syn-depositional relief	**None.**
Internal architecture	Internal bedding.
Facies and sedimentology	
Intra -reef sediment	Dark gray marly bioclastic wackestones; biomicrites (M/S/C: 70/0/30). Significant siliciclastic clay component. Essentially identical to the coral marl of Foug (Lorraine - see chapter 3).
Inter-reef sediment	**Not seen.**
Pre-reef unit	**Relatively deep water ammonitc marls (Terraine à Chailles). Essentially no corals.**
Post-reef unit	**Shallow water platformal St. Ursanne formation (reefs and grainstones).**
Sedimentary structures	**None.**
Early cementation	**No.**
Depositional environment	
Position on platform	**Early in platform evolution; platform wide distribution. Also locally developed on the platform slope towards the basin and deposited contemporaneously with the platform top St. Ursanne Formation.**
Sedimentary regime	**Relatively deep water environment; calm water - well below storm wave base; low light levels; *sedimentation both autochthonous* (fine bioclastics and micrite) and allochthonous (in particular siliciclastic clays).**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**15**
Dominance patterns	**Moderate: *Dimorpharaea* constitutes 50% of the total coral skeletal biovoume. (S-W: 2.47). Dominated by microsolenids especially *Dimorpharaea*.**
Dominant growth form	**Dominated by platy forms (80%).**
General colony size	**2-4 cm thick; 20-30 cm across.**
Coral skeletal biovolume	**Generally high: 40-70.**
Associated fauna	
General development	**Very well developed.**
Main taxa	**Encrusters: serpulid, thecidean brachiopods, calcareous sponges; bryzoans; bivalves. Dwellers: cidaroid echinoids and *Millericrinus* crinoids.**
Extent of bioerosion	**High; boring bivalves.**
Algae	
Type	**Blue-green; reds absent.**
Volume of algae	**Insignificant.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**As thin (generally less than 2 mm thick) crusts on some coral plates.**
Volume	**Insignificant.**
Role in reef-building	**Insignificant.**
Misc.	
Zonation; succession	**Up-section: corals get thicker; more massive domal forms appear; calcareous sponges decrease in number; diversity of cryptic fauna decreases.**

ST. URSANNE (patch-reef 1), SWISS JURA

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**St. Ursanne Formation.**
Stratigraphic age	**Middle Oxfordian: *Transversarium* Zone, *Antecedens* Sub-zone to the base of the *Birficatus* Zone, *Schilli* Sub-zone.**
Dimensions and form	
Reef form	**Domal; roughly circular in plan view.**
Vertical extent	**Approximately 30m.**
Lateral extent	**Approximately 30m.**
Max. syn-depositional relief	**Slight - no more than 2-3m.**
Internal architecture	**None.**
Facies and sedimentology	
Intra -reef sediment	**Large area of the intra-reef sediment is dominated by microbialite biopelmicrtes (see Quatre Pieux and Bois du Parc, Burgundy - chapter 2). Local development of birds eye textures.**
Inter-reef sediment	***Fine to coarse grained bioclastic packstone rich in fragments of red algae and nerineacean gastropods.***
Pre-reef unit	**Slightly oncolitic oolite. The boundary between the reef and pre-reef unit is a trangressive surface.**
Post-reef unit	**Reef capped by a beach facies rich in nerineacean gastropods which is followed by fine fenestrate limestones of the lagoonal Vorbourg Member.**
Sedimentary structures	**None evident.**
Early cementation	**Yes.**
Depositional environment	
Position on platform	**Platform fully developed; platform interior.**
Sedimentary regime	**Very shallow water, probably less than 5m and aggraded to sea level. Very high energy with reef development occurring close to the *inter-tidal zone. The main body of the reef* developed in the upper sub-tidal zone. The reef developed in a pure limestone regime with no siliciclastic influx. The immature nature of the bioclasts suggests that they were rapidly incorporated into framework. Bioclastic material was mainly *a product of physical erosion* and was deposited within the reef but also exported as bioclastic aprons at the reef flanks.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
No. of genera	**29 (very rich).**
Dominance patterns	**Difficult to establish. Plocoid and meandroid forms common.**
Dominant growth form	**Massive dominate though branching phaceloid and *ramose forms also common.***
General colony size	**Massive forms: 20-30 cm thick; 30-40 cm across.**
Coral skeletal biovolume	**Very high 50-90%.**
Associated fauna	
General development	**Very poor.**
Main taxa	**Pectinids; echinoid spines though all taxa rare.**
Extent of bioerosion	**Low-moderate; boring bivalves.**
Algae	
Type	**Mainly red algae.**
Volume of algae	***Can be quite substantial in the upper parts of the reef.***
Role in reef building	**Red algae may have played a local binding role.**
Microbialite	
Type	**Massive and dense; macroscopically structureless. Microscopically: dense rindy; laminated in areas.**
Volume	**Considerable.**
Role in reef-building	**Important; early cementation of the microbialite bound the skeletal framework *together giving the reef structural rigidity.***
Misc.	
Zonation; succession	***Sylinids become more abundant at the top of the reef.***

COURTÉTELLE (reef 5), SWISS JURA

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**St. Ursanne Formation.**
Stratigraphic age	**Middle Oxfordian: *Transversarium* Zone, *Antecedens* Sub-zone to the base of the *Birficatus* Zone, *Schilli* Sub-zone.**
Dimensions and Form	
Reef form	**Domal.**
Vertical extent	**10m.**
Lateral extent	**10m.**
Max. syn-depositional relief	**Slight - no more than 2m.**
Internal architecture	**None.**
Facies and sedimentology	
Intra -reef sediment	**Rindy-laminated microbialite biopelmicrtes (see Quatre Pieux and Bois du Parc, Burgundy - chapter 2).**
Inter-reef sediment	**Fine mudstones.**
Pre-reef unit	**Fine mudstones.**
Post-reef unit	**Fine mudstones.**
Sedimentary structures	**None evident.**
Early cementation	**Yes.**
Depositional environment	
Position on platform	**Platform fully developed; platform interior.**
Sedimentary regime	***Very shallow water, probably less than 5m; very quite water (protected platform interior - "lagoonal").* The main body of the reef developed in the upper sub-tidal zone. The reef developed in a pure limestone regime with no siliciclastic influx. The immature nature of the bioclasts suggests that they were rapidly incorporated into framework.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**12.**
Dominance patterns	**Difficult to establish.**
Dominant growth form	**Massive dominate though branching *phaceloid also abundant. Sub-branching ramose forms present.***
General colony size	**Massive forms: 20-30 cm thick; 30-40 cm across.**
Coral skeletal biovolume	**Very low 20%.**
Associated fauna	
General development	**Very poor.**
Main taxa	**Pectinids; echinoid spines though all taxa rare.**
Extent of bioerosion	**moderate-high; boring bivalves.**
Algae	
Type	**Red algae.**
Volume of algae	**Common.**
Role in reef building	**Common though not important structurally.**
Microbialite	
Type	**Massive and dense; macroscopically structureless. Microscopically: dense rindy; laminated in areas.**
Volume	**Considerable.**
Role in reef-building	**Important; early cementation of the microbialite bound the skeletal framework together giving the reef structural rigidity.**
Misc.	
Zonation; succession	**None evident.**

PÉRY-REUCHENETTE, SWISS JURA

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Günsberg Member.**
Stratigraphic age	**Late Middle Oxfordian: *Bifurcatus* Zone, *Schilli* Sub-Zone - *Bimammatum* Zone, *Hypselum* Sub-Zone.**
Dimensions and form	
Reef form	**Domal to tabular, though framework rather discontinuous.**
Vertical extent	**1-3m (for individual patches).**
Lateral extent	**10m (for individual patches).**
Max. syn-depositional relief	**Slight - no more than 1m.**
Internal architecture	**Internal bedding surfaces are visible and can be traced into the inter-reef sediment.**
Facies and sedimentology	
Intra -reef sediment	**Dark gray marly wackestone; microbialite biopelmicrite (90/0/10). Significant clay component, quartz grains also present.**
Inter-reef sediment	**Marly limestones.**
Pre-reef unit	**Not seen.**
Post-reef unit	**Not seen, though apparently oolites.**
Sedimentary structures	**Storm horizons frequent; local hardgrounds.**
Early cementation	**Yes, especially of crusts.**
Depositional environment	
Position on platform	**Platform fully developed; platform Edge.**
Sedimentary regime	**Relatively shallow water coral reefs. These reefs are likely to have developed in sub-tidal water depths below just FWWB. Well above SWB. General background sedimentation rate can be inferred to be relatively low. Siliciclastic influx was sporadic, probably introduced during storms events which appear to be relatively frequent. The source of the siliciclastics was relatively close to the development of these reefs.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**11.**
Dominance patterns	**Difficult to establish, though *Isastraea, Thecosmilia, Fungiastraea, Calamnophylliopsis and Thamnasteria* are common. *Isastraea* is particularly common.**
Dominant growth form	**Tabular-domal.**
General colony size	**6 cm thick; 20 cm across; domal form up to 20 cm thick.**
Coral skeletal biovolume	**Generally low 20%, can reach 40-50%.**
Associated fauna	
General development	**Moderate.**
Main taxa	**Rhychonellid brachiopods are very common. Also common are small encrusters.**
Extent of bioerosion	**Moderate-high; boring bivalves.**
Algae	
Type	**Red algae present though may not be in-situ.**
Volume of algae	**?common.**
Role in reef building	**Insignificant.**
Microbialite	
Type	**Microbialite columns and knobbly crusts.**
Volume	**Considerable.**
Role in reef-building	**Important; early cementation of the microbialite bound the skeletal framework together giving the reef structural rigidity especially considering the frequent storms.**
Misc.	
Zonation; succession	**Note evident.**

HAYDON WICK, WILTSHIRE, ENGLAND

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Coral Rag; Corallian.**
Stratigraphic age	**Middle Oxfordian (*Cardioceras tenuiserratum* Zone; *C. tenuiserratum* to *C. blakei*).**
Dimensions and form	
Reef form	**Coral patches or thickets; lensoid form.**
Vertical extent	**1 m.**
Lateral extent	**5-10 m.**
Max. syn-depositional relief	**Less than 1 m if any.**
Internal architecture	**None.**
facies and sedimentology	
Intra-reef sediment	**Variable but mainly dark gray wackestone-packstone (M/S/C: 70/5-10/20; biomicrites).**
Inter-reef sediment	**Very variable: bioclastic packstones, shell rich oolitic grainstones, oncoidal grainstones, mudstones, shell-rich debris beds and coral rudstones.**
Pre-reef unit	**Cannot be established.**
Post-reef unit	**Cannot be established.**
Sedimentary structures	**Reef development often interrupted by intra-reef clay bands which are probably storm deposited.**
Early cementation?	**Only of spongiostromate crusts.**
Depositional environment	
Position on platform	**Reef development occurred within a very shallow shelf around small emergent island.**
Sedimentary regime	**The facies association of bioclastic packstones, oolites, oncoidal grainstones and coral biolithites suggests that the coral thickets and patches had developed in very shallow water. The intercalated clay bands within the frameworks suggest that strong siliciclastic influx was likely to have been episodic (at least in intensity) rather than a uniform constant supply. These muddy siliciclastic sediments would have been introduced during storm which appear to be have been quite frequent. Storms were also responsible for the development of many channel sands deposits rich in bivalve and gastropod material. The area represents small scale reef development in a complex environment of sub-tidal sand shoals and channel within a storm dominated regime. In an area where siliciclastic influx was not strong oolitic and oncoidal grainstones developed in higher energy environments. There were two distinct coral frameworks: (1) the *Thamnasteria/Isastraea-dominated* patches; and (2) *Thecosmilian*-dominated thickets. From the facies association it is clear that both these biolithites developed in very shallow water (less than 5 m), and it can speculate that the *Thamnasteria/Isastraea* biolithites, dominated by massive colonies, had developed in slightly higher energy environments, and the *Thecosmilian* thickets, dominated by branching phaceloid forms, were more abundant in the hydrodynamically protected areas.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**4.**
Dominance patterns	**Dominated by *Thamnasteria* and *Thecosmilia*.**
Dominant growth forms	**Tabular to domal (*Thamnasteria*) branching phaceloid (*Thecosmilia*).**
General colony size	**Massive forms: 50 cm across and 30 cm thick. Branching phaceloid: 55 cm high.**
Coral skeletal biovolume	**20-40%.**
Associated fauna	
General development	**Moderate.**
Main taxa	***Nanogyra, Paracidaris* spines and *Rhaxella* spicules.**
Extent of bioerosion	**Bioerosion intensity moderate to high; mainly by bivalves, though *Talpina* also seen.**
Algae	
Type	**None.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**Well developed knobby form of spongiostromate crust.**
Volume	**Extremely abundant as crusts over the coral colonies.**
Role in reef-building	**May have played a locally binding role.**
Miscellaneous	
Zonation; succession	**None evident.**

SHELLINGFORD CROSS ROADS, OXFORDSHIRE, ENGLAND

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	Coral Rag; Corallian.
Stratigraphic age	Middle Oxfordian (*Cardioceras tenuiserratum* Zone; *C. tenuiserratum* to *C. blakei.*
Dimensions and form	
Reef form	Lensoidal.
Vertical extent	Less than 1 m.
Lateral extent	1 to 10 m.
Max. syn-depositional relief	Less than 50 cm, if any.
Internal architecture	Storm erosion surfaces.
facies and sedimentology	
Intra-reef sediment	Mainly *Rhaxella* pelmicrites, though variable.
Inter-reef sediment	Thecosmilian rudstones and biosparite lens (with some in situ corals) where visible.
Pre-reef unit	Urchin Marls.
Post-reef unit	Not visible.
Sedimentary structures	Vague cross bedding in biosparite lenses.
Early cementation?	No.
Depositional environment	
Position on platform	Reef development occurred within a very shallow shelf around small emergent island.
Sedimentary regime	The dominance of the Thecosmilian rudstone facies suggests that the majority of the section represents rubble from *Thecosmilia* thickets such as those of Haydon Wick, which were probably storm generated. Where in situ reef development does occur, such as within the biosparitic lenses, the sediments are clean grainstones suggesting high energies, or *Rhaxella* biomicrites suggesting low energies. Clay bands, although present, are not as frequent as they are in the Haydon Wick section, possibly suggesting a more distal source. The *Thamnasteria/Isastraea* biolithites are essentially the same as those from Haydon Wick and are considered to have developed in a similar environment.

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	4
Dominance patterns	High: *Thecosmilia* and *Thamnasteria* together constitute 80% of the total coral skeletal biovolume.
Dominant growth forms	Tabular to low domal forms (*Thamnasteria*) and branching phaceloid (*Thecosmilia*).
General colony size	Massive: 80-150 cm across and 10-40 cm thick; phaceloid up to 1 m high and 30-40 cm across.
Coral skeletal biovolume	*Thamnasteria* biolithite: 20-40%; *Thecosmilia* biolithite: 30-60%.
Associated fauna	
General development	Moderately well developed.
Main taxa	*Nanogyra* very common. Also present: *Chlamys*, *Plagiostoma*, *Metriomphalus*, thecidean brachiopods, *Rhaxella*, *Paracidaris* spines.
Extent of bioerosion	Moderate; solely by bivalves.
Algae	
Type	None.
Volume of algae	———
Role in reef-building	———
Microbialite	
Type	Mainly planar spongiostromate crusts, though knobby forms also present.
Volume	Present though not common.
Role in reef-building	None.
Miscellaneous	
Zonation; succession	None evident.

UPWARE, CAMBRIDGESHIRE, ENGLAND

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**"Coral Rag"; West Walton Beds.**
Stratigraphic age	**Middle Oxfordian (*Cardioceras tenuiserratum* Zone; *C. tenuiserratum* to *C. blakei*.**
Dimensions and form	
Reef form	**sheet-like (biostromal); occasionally thin lensoidal.**
Vertical extent	**1-2 m thick.**
Lateral extent	**10-20 m across.**
Max. syn-depositional relief	**Zero.**
Internal architecture	**Internally bedded.**
facies and sedimentology	
Intra-reef sediment	**White, coarse-grained bioclastic to oncolitic packstone (M/S/C: 20-30/0/70-80; bio-oncopelmicrite).**
Inter-reef sediment	**Pelmicrites.**
Pre-reef unit	***Pelmicrites and clays of the basal West Walton.***
Post-reef unit	**Not seen.**
Sedimentary structures	**None.**
Early cementation?	**No.**
Depositional environment	
Position on platform	***Reef development occurred within a very shallow shelf around small emergent island.***
Sedimentary regime	**Low-energy, relatively deep-water environment, in which sediments from shallower-water facies were occasionally washed in.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**8.**
Dominance patterns	**High: *Microsolena* constitutes 46% of the total coral skeletal biovolume; microsolenids (*Microsolena* and Dimorpharaea: 66%).**
Dominant growth forms	**Platy (80% of total skeletal biovolume).**
General colony size	**0.5-8 cm thick; up to 35 cm across.**
Coral skeletal biovolume	**20-50%.**
Associated fauna	
General development	**Very well developed.**
Main taxa	***Chlamys, Isoarca, Opis, Arca, Plagiostoma, Barbatia, Nanogyra, Lopha, Lithophaga, Paracidaris*, thecidean brachiopods, calcareous sponges, serpulids.**
Extent of bioerosion	**High: mainly by bivalves, although *Talpina* and *Entobia* also present.**
Algae	
Type	**None.**
Volume of algae	———
Role in reef-building	———
Microbialite	
Type	**Planar sponglostromate crusts.**
Volume	**Can be common.**
Role in reef-building	**None.**
Miscellaneous	
Zonation; succession	**None evident.**

AYTON, YORKSHIRE, ENGLAND

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Top of the Malton Oolite.**
Stratigraphic age	**Middle Oxfordian (*Cardioceras tenuiserratum* Zone; *C. tenuiserratum* to *C. blakei*..**
Dimensions and form	
Reef form	**Domal-lensoid in form.**
Vertical extent	**2 m.**
Lateral extent	**2-6 m.**
Max. syn-depositional relief	**Up to ?1 m.**
Internal architecture	**None.**
facies and sedimentology	
Intra-reef sediment	**Oo-oncobiosparite; M/S/C: 0/50/50, locally biomicrites in more protected areas (M/S/C: 0/50/50).**
Inter-reef sediment	**Solenopora-gastropod facies of the Malton Oolite, commonly deposited within channels or as sheets.**
Pre-reef unit	**As above.**
Post-reef unit	**As above.**
Sedimentary structures	**None evident.**
Early cementation?	**There is no evidence for early cementation.**
Depositional environment	
Position on platform	**Reef development occurred within a very shallow shelf around small emergent island.**
Sedimentary regime	**The *Thamnasteria* biolithites occurred in very shallow water (less than 5 m), clean, relatively high-energy environments, in and around stable oolite shoals and channels.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**3**
Dominance patterns	**Very high: reefs composed almost totally of *Thamnasteria* (this constitutes over 95% of the total coral skeletal biovolume). Other corals are *Isastraea* and *Rhabdophyllia*.**
Dominant growth forms	**Domal.**
General colony size	**1 m across and 30-40 cm high.**
Coral skeletal biovolume	**90%**
Associated fauna	
General development	**Poor.**
Main taxa	***Nanogyra* and *Lithophaga* are the most conspicuous groups.**
Extent of bioerosion	**High; *Lithophaga***
Algae	
Type	**Red algae (although none definitely found within the reef framework).**
Volume of algae	**None found in the reefs themselves (however red algae has been found in the adjacent oolite).**
Role in reef-building	**None.**
Microbialite	
Type	**Only as spongiostromate crusts.**
Volume	**Not common.**
Role in reef-building	**None.**
Miscellaneous	
Zonation; succession	**None evident.**

AL FARO REEF; SEAWARD ZONE, FRIULI, ITALY

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Polcenego Limestone.**
Stratigraphic age	**Late Oxfordian to Early Kimmeridgian.**
Dimensions and form	
Reef form	**Unattainable from outcrop.**
Vertical extent	**At least 15 m.**
Lateral extent	**Atl east 30 m.**
Max. syn-depositional relief	**Cannot be established.**
Internal architecture	**None.**
facies and sedimentology	
Intra-reef sediment	**Hard dense intraclastic grainstone (bio-intrasparite; M/S/C: 0/40/60). The facies and microfacies are very similar to those described from Quatre Piexe, Burgundy, although peloidal fabrics are less abundant.**
Inter-reef sediment	**Not visible.**
Pre-reef unit	**Not visible.**
Post-reef unit	**Conglomerate with rounded reefal fragments; beach facies; gastropod rich grainstones.**
Sedimentary structures	**None.**
Early cementation?	**Yes.**
Depositional environment	
Position on platform	**Rim-type platform. Reef development located on the platform edge**
Sedimentary regime	**The seaward zone reef is associated with the beach facies and hence can be assumed to have developed in a high energy environment. The sparseness of peloidal material and the dominance of sparite cements in the seaward zone reef is likely to be a consequence of the high energy levels.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**6.**
Dominance patterns	**Cannot be established due to poor coral preservation.**
Dominant growth forms	**Domal massive (80%).**
General colony size	**30-50 cm across 20 cm thick**
Coral skeletal biovolume	***50-60%***
Associated fauna	
General development	**Very poor.**
Main taxa	***Mainly cheatetids and pectinids.***
Extent of bioerosion	**Very low; solely by small organisms such as forams.**
Algae	
Type	**None seen.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**(1) Massive, macroscopically structureless; microscopically laminated (fine agglutinated stromatolites) (2) Spongiostromate crusts (poorly developed)**
Volume	**Massive; macroscopically structureless; microscopically laminated microbialite very abundant - dominates areas of the intra-reef sediment.**
Role in reef-building	**Fundamental: early cementation of microbialite bound the skeletal framework giving the reef structural rigidity.**
Miscellaneous	
Zonation; succession	**None seen.**

AL FARO REEF; LAGOONWARD ZONE, FRIULI, ITALY

REEF STRUCTURE AND FACIES

Reef feature	
General	
Unit name	**Polcenego Limestone**
Stratigraphic age	**Late Oxfordian to Early Kimmeridgian**
Dimensions and form	
Reef form	**Cannot be established from outcrop.**
Vertical extent	**At least 15 m.**
Lateral extent	**At least 50 m.**
Max. syn-depositional relief	**Cannot be established.**
Internal architecture	**None.**
facies and sedimentology	
Intra-reef sediment	**Microbial biopelmicrites (M/S/C ratio: 70-60/10-15/30-20)**
Inter-reef sediment	**Grade from bioclastic grainstones to laminated, fenestrate mustones.**
Pre-reef unit	**Not seen.**
Post-reef unit	**Beach facies.**
Sedimentary structures	**Small scale channeling.**
Early cementation?	**Yes.**
Depositional environment	
Position on platform	**Rim-type platform. Reef development located lagoonward just behind outer reef development.**
Sedimentary regime	**The lagoonward zone reef, although onlapped by beach facies, is closely associated with the fenestrate pelmicrites and therefore energy levels were likely to have been significantly lower. This is reflected in the intra-reef microfacies which contains of much less sparite cement, less bio- and lithoclastic material and dominated by peloidal fabrics.**

PALAEOECOLOGY

Reef feature	
Coral fauna	
Number of genera	**12**
Dominance patterns	**Difficult to evaluate although *Pseudocoenia* and *Calamophylliopsis* are common.**
Dominant growth forms	**Massive (40%) and branching phaceloid (40%); branching ramose (20%).**
General colony size	**Massive forms as seaward zone; branching forms up to 1.5 m high and 1m across.**
Coral skeletal biovolume	**50-60%**
Associated fauna	
General development	**Low-moderate.**
Main taxa	**Cheatetid domes are common as echinoid spines and pectinids. Small encrusters are abundant especially problematic forms such as *Lithocodium* and *Bacinella* These occur both as distinct individuals. and/or indistinct coatings; they are especially abundant around the phaceloid coral branches. Also present are Nubeculinid forams, Serpulids, *Cayuxia, Girvenella,* Bryozoans and *Neuropora.***
Extent of bioerosion	**Low; although small boring organisms such as forams are common.**
Algae	
Type	**None seen.**
Volume of algae	_____
Role in reef-building	_____
Microbialite	
Type	**(1) Massive, macroscopically structureless; microscopically laminated. (2) Spongiostromate crusts (poorly developed); (3) porostromate crusts and other small chambered encrusters of uncertain affinity. (relatively common).**
Volume	**Massive; macroscopically structureless; microscopically laminated microbialite very abundant - dominates the intra-reef sediment.**
Role in reef-building	**Important: early cementation of microbialite bound the skeletal framework giving the reef structural rigidity.**
Miscellaneous	
Zonation; succession	**None seen.**

Appendix 2: Growth rate data.

(See section 8.2.4.3 and table 8.7 for locality details and summary of results.)

Yorkshire: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
0.8	0.3	0.9	0.3	0.8	0.1
0.8	0.3	0.9	0.3	0.9	0.3
0.8	0.3	0.8	0.6	0.9	0.3
0.7	0.2	0.7	0.2	0.8	1
0.8	0.3	0.8	0.3	0.7	0.4
0.7	0.2	0.9	0.5	0.9	0.3
0.5	0.3	0.8	0.6	0.7	0.4
0.4	0.3	0.6	0.5	0.8	0.3
0.6	0.5	0.7	0.2	0.8	0.6
0.5	0.7	0.8	0.6	0.7	0.4
0.6	0.5	0.5	0.3	0.9	0.1
0.8	0.3	0.6	0.5	0.9	0.5
0.6	0.5	0.9	0.5	0.8	0.3
0.7	0.2	0.8	0.6	0.9	0.3
0.4	0.3	0.7	0.4	0.8	1
0.9	0.3	0.8	1	0.8	0.3
0.8	0.3	0.8	0.6	0.7	0.8
0.7	0.2	0.8	0.6	0.9	0.8
0.8	1	0.7	0.4	0.9	0.8
0.8	0.3	0.9	0.5	0.8	0.6
0.8	0.3	0.7	0.4	0.8	0.1
0.8	0.3	0.8	0.6	0.8	0.1
0.8	0.6	0.8	0.6	0.8	0.3
0.7	0.4	0.9	0.8	0.8	0.1
0.9	0.5	0.8	0.1	0.9	0.5
0.7	0.4	0.9	0.3	0.6	0.5
0.7	0.4	0.7	0.4	0.7	0.4
0.8	0.3	0.7	0.4	0.8	0.3
0.8	0.3	0.8	0.6	0.5	0.3
0.8	0.3	0.9	0.5	0.6	0.5
0.8	0.3	0.9	0.1		
0.8	0.3	1	0.4		
0.8	0.6	1.1	0.4		
0.9	0.5	0.9	0.6		
1	0.4	0.8	0.2		

Oxfordshire: *Thamnasteria concinna*

GR	L/H
1.2	0.7
1.3	0.2
1.2	1
1.2	1.4
1.1	0.2
1.2	0.7
1.2	0.3
1.4	0.1
1.2	0.2
1.3	0.3
1	0.3
1.2	0.2
1.3	0.1
1.1	0.6
1	0.3
1.4	0.1
1.2	0.1
1.3	0.9
1.3	0.2
1.3	1.6

GR	L/H
1	0.5
1.1	0.2
1.2	1.4
1.2	1.4
1.3	0.1
1.2	0.2
1	0.7
1.2	0.7
1.2	0.7
1.1	1.2
1.2	0.1
1.5	0.9
1.2	0.2
1.2	0.7
1.3	0.1
1.3	0.4
1.3	0.6
1.4	0.6
1.2	0.5
1.3	0.4

GR	L/H
1.3	1.2
1.4	0.3
1.4	0.8
1.3	0.2
1.3	0.9
1.3	1.6
1.2	2
1.3	1.2
1.2	1
1.2	0.1
1.2	0.7
1.3	0.2
1.3	0.9
1.2	0.1
1.3	0.9

Oxfordshire: *Isastraea explanata*

GR	L/H
3	0.1
2.6	0.2
2.7	0.4
2.8	0.6
3	0.5
2.9	0.5
2.8	0.2
2.4	0.3
2.5	0.6
2.5	0.4
2.3	0.9
2.1	1.6
2.5	0.5
2.5	1.1
2.3	0.1

GR	L/H
2.6	0.4
2.5	0.7
2.5	0.3
2.6	0.7
2.7	0.1
2.4	0.4
2.6	0.1
2.5	0.5
2.6	0.6
2.1	0.2
2.7	0.9
2.6	0.1
2.8	0.6
2.7	1.7
2.5	0.3

GR	L/H
2.5	0.1
2.4	0.7
2.3	0.8
1.5	0.9
2.3	1.3
2	0.3
2.5	0.1
2.6	0.6
2	0.1
2.3	0.6

Upware: *Thamnasteria concinna*

GR	L/H
1	0.4
0.8	1
0.8	0.3
0.7	1.3
0.9	0.5
0.6	0.5
0.7	0.2
0.8	0.1
0.9	0.3
0.8	0.3
0.9	0.3
0.8	0.6
0.8	0.3
1.1	0.2
0.8	0.6

GR	L/H
1	0.7
1	0.7
0.9	0.8
0.7	0.2
0.9	0.5
0.9	0.3
0.9	1.3
1	0.7
1	0.4
1	0.3
0.8	0.1
0.7	0.1
0.9	0.8
0.8	0.2
0.8	0.3

GR	L/H
0.9	0.5
0.9	0.5
0.7	0.8
0.8	1
0.6	0.5
0.7	0.8
0.9	0.8
0.9	0.8
0.8	0.1
0.8	0.3

Upware: *Isastraea explanata*

GR	L/H
1.8	0.6
2	0.3
2.1	0.5
2.3	0.5
2.1	0.8
2.1	0.1
2.3	0.3
2.7	1.5
3	0.5
2.4	0.1

GR	L/H
2.4	0.5
2.8	0.3
2.2	0.3
2.1	1.1
1.7	1.4

GR	L/H
1.8	0.1
2	0.3
2.6	0.4
1.8	0.3
2	0.1

Foug 1: *Thamnasteria concinna*

GR	L/H
0.9	0.8
1	0.4
0.9	0.3
0.8	0.3
1	0.7
1.1	0.6
1	0.7
1.1	0.6
1.2	0.7
1.2	1.4
0.9	0.8
0.9	0.5
1	0.4
1	0.1
1.2	0.7
1.3	0.3
1.1	0.6
1	0.3
1.2	0.7
1.2	0.7
1	0.4
1	0.7
1	0.3
1.2	0.1
0.9	0.3

GR	L/H
0.8	0.1
0.7	0.4
0.8	0.3
0.9	0.5
1.2	0.5
1.3	0.6
1.2	0.2
1.1	0.1
1.2	0.2
1.2	0.3
1	0.4
1.2	0.3
1.3	0.2
1.2	0.5
1.2	0.2
1.3	0.3
0.9	0.1
0.9	0.6
0.8	0.3
0.8	0.1

GR	L/H
1.2	0.3
1.2	0.2
1.1	0.4
1	0.3
1	0.1
0.9	0.1
0.9	0.1
1	0.1
1	0.3
1.1	0.8
1.1	0.8
0.8	0.1
1	0.1
1.2	0.2
1	0.1
1	0.8
1.1	0.7
1.1	0.1
1.2	0.3
1.2	0.7

Foug 1: Isastraea explanata

GR	L/H	GR	L/H	GR	L/H
2.5	0.5	2.2	0.7	2.7	0.4
2.6	0.5	2.1	0.2	3.1	0.9
2.3	0.9	2.6	0.5	3	1.3
2.5	0.8	2.7	0.7	3.3	0.2
2.3	0.1	2.5	0.3	3	0.2
2.7	0.8	2.5	0.3	2.9	1
2.9	0.9	2.3	1.3	2.6	1
3.2	0.9	2.3	0.5	2.4	0.3
2.8	1	2.6	0.5	2.7	0.9
3	0.9	2.3	1.6	2.3	0.3
2.5	0.3				
2.5	0.1				
2.6	0.4				
2.6	0.4				
2.6	0.4				

Foug 2: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
1.2	0.3	1.2	0.1	1.2	0.1
1.1	0.2	1.3	0.3	1.2	0.7
1.2	0.3	1.2	0.2	1	0.3
1.3	0.6	1.3	0.4	1.3	0.4
1.2	0.7	1.3	0.4	1.3	0.2
1.2	1	1.3	1.6	1.2	0.5
1.2	0.3	1.2	0.5	1.2	0.7
1.3	0.1	1.3	1.2	1.4	0.4
1.4	1.3	1.3	1.2	1.4	0.4
1.1	1.2	1.3	0.3	1.4	0.6
1.4	0.1	1.2	0.7	1.3	0.6
1.7	0.3	1.3	0.6	1.1	1.2
1.2	0.7	1.4	0.3	1	0.1
1.2	0.7	1.2	0.7	1.2	0.2
1.3	0.3	1.2	0.5	1.2	0.3
1.3	0.4				
1.4	1				
1.3	0.9				
1.3	0.2				
1.3	0.4				

Foug 2: *Isastraea explanata*

GR	L/H
2.6	0.5
2.5	0.6
2.4	0.8
2.4	0.1
2.3	0.1
3	0.5
3.2	1.5
3.3	0.1
3.2	1.1
3.3	0.8

GR	L/H
3	0.7
3.2	1
3.4	1.1
3.2	1
3.3	1.1
3	0.6
3.1	0.6
3.1	0.4
3.2	0.5
3	1.1

GR	L/H
2.6	1
2.8	0.9
2.9	0.8
2.9	0.8
2.9	0.8

Haudainville: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
2.9	1.4	2.5	1.8	2.8	1.1
2.9	1.2	2.8	1.5	2.7	1.3
2.6	1.4	2.6	1.9	2.6	1.4
2.9	1.2	2.8	1.8	2.6	1.2
2.9	1.2	2.7	2	2.4	1.4
2.6	1.6				
2.4	1.4				
2.9	0.7				
2.5	1.5				
2.4	1.2				

Haudainville: *Isastraea explanata*

GR	L/H	GR	L/H	GR	L/H
4	1.7	3.6	0.8	3.6	0.8
4	1.3	3.5	1.3	3.8	0.6
3.8	1.9	4	1.1	3.2	1.1
3.8	1.4	3.5	1.7	3.4	2.1
3.4	0.7	2.9	1.1	3.2	1.8

St. Mihiel: *Thamnsteria concinna*

GR	L/H
2	1.2
2	1.5
2.3	1.9
2.4	1.8
2.3	1.1
2.4	0.7
2.4	1
2.3	1.1
2.5	1.1
2.4	1.2

GR	L/H
2.5	1
2.7	0.9
2.5	0.5
2.4	1.1
2.7	2
2.6	1.2
2.4	1
2.5	0.9
2.5	1.1
2.4	2

GR	L/H
2.4	1
2.5	0.9
2.6	1
2.6	1
2.4	0.9

St. Mihiel: *Isastraea explanata*

GR	L/H
3.9	1.1
3.6	1.3
3.8	1.2
3.5	0.8
3.4	0.7

GR	L/H
3.6	2
3.5	2.1
3.2	2.6
3.5	0.4
3.2	0.6

GR	L/H
3.6	1.4
3.4	1
3.2	1
2.8	2.1
3.2	1.7

Châtel-Censoir: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
1.2	0.3	1.4	0.8	1.1	1.2
1.3	0.9	1.2	1	1.3	1.2
1.1	0.8	1.3	0.3	1.3	0.2
1.2	0.5	1.3	1.2	1.2	0.5
1.2	0.3	1.2	0.5	1.2	0.3
1.1	1.2	1	0.4	1	0.4
0.9	0.8	1.1	0.8	1.2	0.5
0.8	0.6	1.2	0.3	1	0.4
1.2	1.4	1.3	0.3	1.1	0.6
1.2	1.4	1.2	1.4	1	0.7
1.3	1.6				
1.2	0.7				
1.1	0.4				
1	1.2				
1.1	0.4				

Châtel-Censoir: *Isastraea explanata*

GR	**L/H**	**GR**	**L/H**	**GR**	**L/H**
3.3	0.7	2.9	0.8	3.1	0.4
3.1	0.1	2.8	0.5	3.3	0.7
3.5	0.2	3.2	1	3.2	0.2
3.4	0.7	3.1	0.2	3.2	0.9
3.3	0.6	2.5	0.6	3.3	0.8
2.6	0.7	3	0.5		
2.7	0.5	3.3	0.7		
3	0.3	3.2	0.2		
3.5	0.2	3.3	0.3		
3.5	0.3	3.3	0.2		

Saussois: *Thamnasteria concinna*

GR	L/H
2.8	1.2
2.8	1.3
3	1.5
3	1.5
2.9	1.9
3	1.3
2.9	1.6
3.1	1.1
3.1	1.4
3	2

GR	L/H
3	1
3	1.7
3.1	1.8
3.2	2.2
3.3	2.3
3	2.3
3	0.8
3	0.6
2.9	1.9
2.8	1.8

GR	L/H
3.1	1.8
3.1	0.8
3.1	1.1
3.2	2.2
3.1	0.6
2.9	1.9
3.1	1.2
3.1	0.6
3.1	0.9
3.1	0.9

Saussois: *Isastraea explanata*

GR	L/H
4.1	2.2
3.2	1.7
3.5	1.1
3.4	1.3
3.6	2.3
3.5	1.7
3.7	1.8
4.2	1.6
3.6	2.3
4.3	2.6

GR	L/H
3.8	1.4
3.3	1.5
3.9	1
3.7	0.9
3.6	0.8

GR	L/H
4	1.9
3.8	1
3.6	1.4
3.6	1.4
3.4	1.3

Liesberg: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
1.6	0.6	1.6	0.2	1.5	0.7
1.4	0.8	1.2	0.7	1.4	1
1.5	0.4	1.5	0.2	1.3	0.9
1.6	1.3	1.6	0.1	1.4	1.3
1.4	0.2	1.5	0.1	1.3	0.6
1.4	0.6	1.4	0.3	1.5	0.4
1.5	1.1	1.5	1.1	1.4	1
1.6	1.3	1.4	1	1.6	0.1
1.5	1.1	1.8	1	1.5	0.2
1.3	1.6	1.5	0.5	1.5	0.2
1.7	0.4	1.4	0.4	1.4	0.3
1.6	0.6	1.5	0.1	1.3	0.1
1.5	0.5	1.2	0.1	1.5	0.9
1.6	0.8	1.6	0.1	1.4	0.3
1.8	0.8	1.5	0.5	1.7	0.5
1.7	0.4	1.5	0.1	1.3	1.2
1.5	0.7	1.3	0.2	1.5	0.4
1.3	0.1	1.5	0.4	1.2	0.5
1.4	0.2	1.6	0.2	1.5	0.1
1.5	0.2	1.5	0.9	1.5	0.7
1.6	1.3	1.6	1.3	1.3	0.1
1.3	1.6	1.3	0.6	1.2	1
1.3	0.2	1.2	0.7	1.5	0.3
1.5	1.1	1.4	0.2	1.6	0.1
1.5	0.3	1.5	0.2	1.2	0.2
1.3	1.2	1.5	0.2		
1.3	0.4	1.3	0.1		
1.2	0.2	1.6	0.5		
1.3	0.4	1.5	0.7		
1.2	0.3	1.4	0.2		

Liesberg: *Isastraea explanata*

GR	L/H	GR	L/H	GR	L/H
2.7	1.5	2.9	0.8	2.5	0.3
3.1	0.5	2.8	0.9	2.6	0.9
2.7	0.2	2.8	0.1	2.7	0.6
3.2	0.9	2.6	0.7	2.8	0.6
3.2	0.5	2.8	0.8	2.7	0.6
2.7	0.2	2.8	1.8	3.1	0.9
2.9	0.1	2.8	0.1	3	0.1
2.8	0.2	3.1	0.1	2.8	0.1
3.3	0.1	2.4	0.7	2.9	0.7
3.2	0.7	3	1.3	2.6	0.1
2.3	1.1	2.5	0.1	2.8	0.1
2.2	0.4	2.6	0.6	2.6	0.7
2.3	0.6	2.8	0.8	2	0.7
2.4	0.3	2.9	0.1	2.9	0.1
2.6	0.4	2.8	0.1	3.2	0.1
3	0.1	2.7	1	3.2	0.1
3.1	0.5	2.8	0.3	3	0.8
3.1	0.6	2.9	0.2	3.2	0.9
3	0.1	2.9	0.1	2.7	0.2
2.8	0.2	3.1	0.5	3.2	0.1
3.1	0.1	2.8	0.1		
3.1	0.7	2.7	0.7		
3.2	0.6	2.8	0.9		
2.7	0.3	3	0.1		
3	0.2	2.9	0.2		

Courtételle: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
2.6	2.3	2.6	1.4	2.4	2
2.5	1.3	2.7	1.1	2.3	1.6
2.4	2.4	2.4	1.4	2.5	2.1
2.6	1.4	2.5	1.3	2.6	2.7
2.5	1.8	2.5	2.1	2.5	1.8
2.4	1	2.2	2.7	2.3	2.8
2.5	1.3	2.5	2.6	2.4	1.7
2.4	1	2.4	2.4	2.3	1.6
2.4	2.1	2.5	2.1	2.6	1
2.3	1.9	2.5	1.1	2.6	1.2
2.6	1.4	2.4	1.7		
2.7	1.7	2.5	1.1		
2.6	1.6	2.3	1.1		
2.7	1.1	2.5	1.8		
2.6	1.2	2.5	1.1		

Courtételle: *Isastraea explanata*

GR	L/H	GR	L/H	GR	L/H
4	1.4	3.7	1.6	3.8	0.9
4.1	1.7	3.5	1.7	3.7	2.4
3.9	1.2	2.8	1.5	3.9	1.9
3.8	1.4	4	1.5	3.9	1
3.9	1.3	3.9	1.2	4	1

St. Ursanne: *Thamnasteria concinna*

GR	L/H	GR	L/H	GR	L/H
2.7	0.6	2.8	1.3	2.8	2.2
2.5	1.3	2.6	2.1	2.9	1.2
2.6	2.3	2.9	1.1	2.8	1
2.8	1.1	2.6	1.2	2.6	1.2
2.6	0.6	2.6	1.6	2.8	1.2
2.9	0.8	2.8	1.8	2.8	1
2.9	1.2	2.8	1	2.9	0.5
3	1.5	2.7	2.9	2.8	1.8
2.8	2.5	2.8	1	2.7	1.1
2.9	1.4	2.8	0.4	2.9	1.1

St. Ursanne: *Isastraea explanata*

GR	L/H	GR	L/H	GR	L/H
3.7	1.5	3.8	2.6	4.2	2.2
4.1	2.1	3.8	1.7	3.9	1.1
4.2	1.3	4	1.2	4	1.1
3.9	1.2	4.6	1.6	4.1	0.6
4.1	1.3	4.2	1	4.1	1.3
3.9	1.6				
4	1				
3.9	2.5				
2.9	1.4				
4.1	1.9				